4. Physical Environment (topography, soils, water, air)

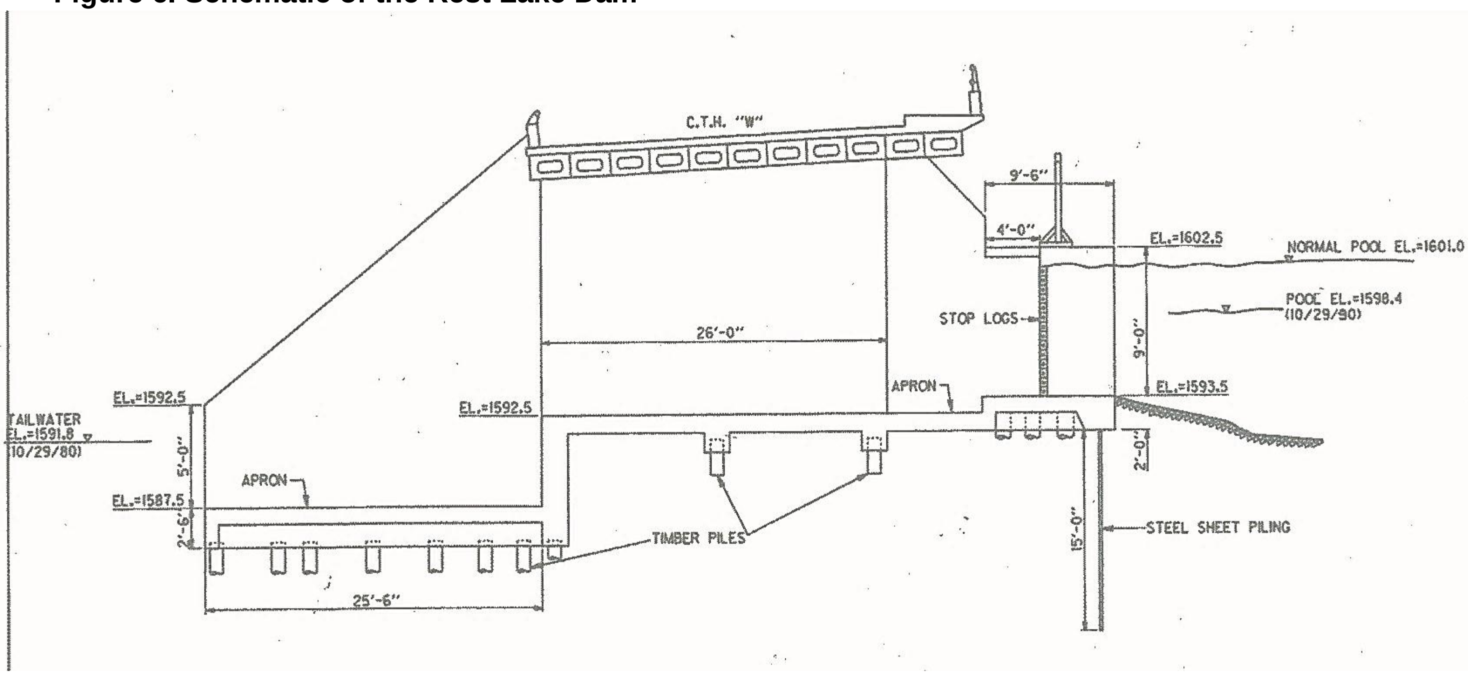
Landscape

The landscape of the Manitowish River system is characterized as a pitted outwash plain with a high density of lakes and wetlands that were created during the retreat of ice during the Wisconsin period of glaciation. The landscape is generally flat, 0 to 2 percent slopes, and the soils in the area are acidic, sandy, very well drained, and have a shallow organic layer horizon.

Surface Waters Affected by the Operation of the Dam

The current maximum water elevation upstream of the dam is measured as 8' 6" on a gage at the Rest Lake Dam which corresponds to an elevation of 1601.0 NGVD (National Geodetic Vertical Datum). The elevation of the apron below the water control gate and stop logs is 1593.5. If the dam were removed, depending on the removal techniques and outlet characteristics left in place, elevations upstream of the dam would be expected to drop to between 1591.8 (the tailwater elevation recorded downstream of the dam on October 29, 1980) and 1587.5 (the elevation of the lowest apron spillway on the dam). These elevations correspond to a drop in water levels upstream of the dam of 9.2 to 13.5 feet (Figure 6).

Figure 6. Schematic of the Rest Lake Dam



The current operation of the Rest Lake Dam affects lake levels upstream on Rest, Clear, Fawn, Stone, Spider, Island, Wild Rice, Alder, Manitowish, and Little Star Lakes (figure 1), and Vance, Sturgeon, and Benson Lakes, along with the Manitowish River downstream from the dam (figure 2). During the summer maximum water level of 8'6", aerial photographs of the reservoir show the backwater of the dam extends to approximately 3,000 feet upstream of CTH 'K' on Papoose Creek, to approximately 800 feet upstream of CTH 'K' on Rice Creek, to approximately one mile upstream of Island Lake on the Manitowish River, and to approximately Gresham Creek on the Trout River near CTH 'H'. The total surface water area of these lakes and connecting channels at the full pool 8' 6" elevation is 4,392.4 acres. At a 3 foot drawdown, based on USGS estimates, there are 3736.4 acres of surface water and 656 acres of dewatered lakebed. The Chain also has approximately 60 miles of shoreline, including islands. The physical characteristics of the Chain of Lakes above the dam and the lakes below the dam are summarized in table 3 on the following page.

Table 3. Characteristics of Lakes Affected by the Rest Lake Dam

Lake	Acreage	Maximum Depth (feet)	Mean Depth (feet)	Miles of Shoreline (includes Islands)	Lake Bed	Lake Type
Above the dam:						
Rest	808	53	18	7.99	SD, GR, RK	DG
Stone	139	43	12	3.56	SD, GR	DG
Fawn	74	14	7	2.76	SD, GR	DG
Clear	555	45	16	7.05	SD, RK, GR	SP
Spider	272	43	20	5.92	SD, RK, GR	DG
Island	1023	35	13	16.75	SD, RK, GR, MK	DG
Manitowish	496	61	23	7.6	SD, RK, GR, MK	DG
Little Star	245	67	31	3.79	SD, RK, GR, MK	DG
Alder	286	33		3.9	SD, RK, GR, MK	DG
Wild Rice	379	26	11	3.71	SD, RK, GR, MK	DG
Below the dam:						
Vance	30	12			SD, RK	DG
Benson	28	15			SD, GR, RK	DG
Sturgeon	32	18			SD, RK, GR, MK	DG

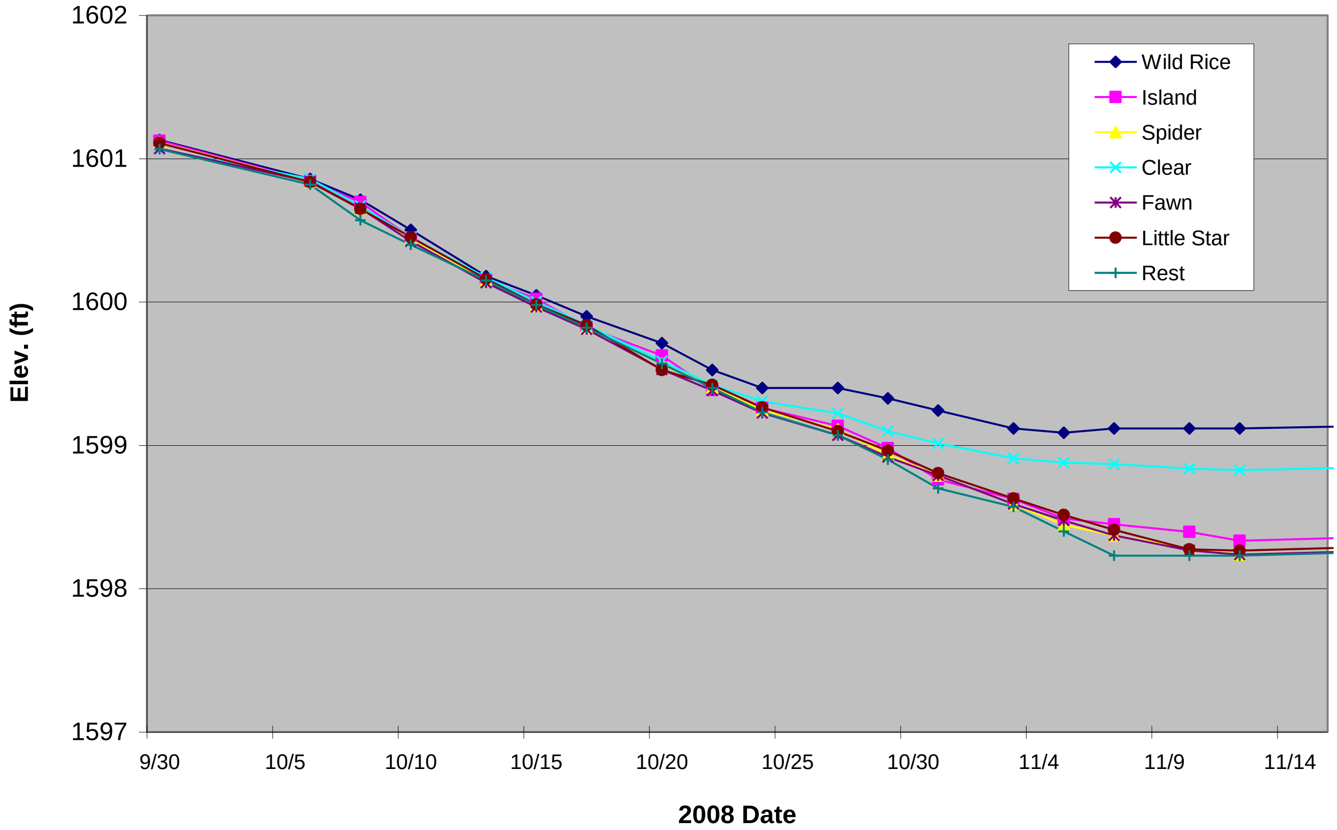
Abbreviations:

SD = sand RK = rock DG = drainage
GR = gravel MK = muck SP = seepage

With the flat topography, water level fluctuations that occur at the dam are quickly mirrored throughout the Chain of Lakes. Survey field data have confirmed that a water level drop at the Rest Lake dam corresponds with a similar water level fluctuation on Rest, Island, Spider, Fawn, and Little Star Lakes (Figure 7). The water levels on two lakes, Wild Rice Lake and Clear Lake, did not decrease as much as the others on the Chain when the reservoir approaches current winter drawdown levels. When the survey was conducted, the amount of drawdown on Wild Rice Lake was still influenced by the Alder Lake Road culvert on the Trout River. The Township recently replaced this structure with a bottomless arch culvert, and it is likely that Wild Rice Lake will react to water level fluctuations similar to other lakes on the Chain. The extent of drawdown on Clear Lake is still affected by the elevation of the shallow streambed connection between Clear and Fawn Lakes.

Downstream of the Rest Lake Dam, the Manitowish River flows through three small lakes and then travels about 15 miles to where the Manitowish and Bear Rivers combine to become the Flambeau River (figure 2 & table 3). Along the River, there are small tributary inflows identified on USGS topographic maps at Circle Lilly Creek, a small unnamed tributary near the Highway 51 wayside park, and four other unnamed tributaries. There are dams on two of these tributaries, the Brandt Lake Dam and Circle Lily Dam. The majority of the river flow below the Rest Lake Dam down to the Turtle Flambeau Flowage comes from the flows discharged from the dam.

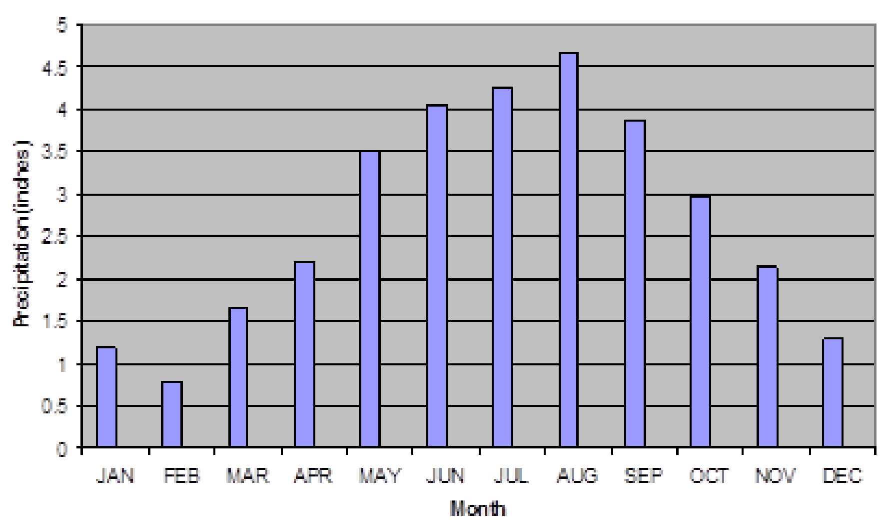
Figure 7: Drawdown Rates of the Lakes on the Chain



Watershed and Reservoir Inflows

The drainage area of the Rest Lake reservoir is about 231 square miles. The basin is composed of approximately 34 square miles of open water (e.g. the reservoir itself and other directly connected surface waters), 51 square miles of connected wetlands, 114 square miles of connected uplands, and 32 square miles of isolated waterways and wetlands (e.g. isolated areas that do not drain to the reservoir through surface waters or connected wetlands) (Rudolph, R.M., et. al.). On average, there is 34 inches of annual precipitation which includes 85 inches of annual snowfall in this watershed. The normal monthly precipitation for this area of the State is shown on Figure 8.

Figure 8. Rest Lake 1971-2000 Precipitation (Wisconsin State Climatology Office)



There are three dams located in the headwaters of the Rest Lake Reservoir, the Fishtrap Dam on the Manitowish River, and the two dams on Mann Creek (a tributary to the Trout River). All three dams have little to no measurable impact on the timing or extent of inflows to the Rest Lake Chain. The major inflow contributions to the reservoir (from largest to smallest inflows) come from the Manitowish River, Trout River, Rice Creek, Papoose Creek, Gresham Creek, and the groundwater flow from Clear Lake. The major inflow sources to the Chain were recorded monthly in 2009 and the percent contribution of each was:

- Manitowish River: 48%
- Trout River: 28%
- Rice Creek: 15%
- Papoose Creek: 7%
- Gresham Creek: 2%

Groundwater is another important source of water input to the reservoir, however, the amount of water that groundwater contributes to the system is very difficult to study and is not fully understood. The Inventory of Wisconsin's Springs identifies surface groundwater spring inputs on the western shore of Clear Lake, the lake bed of Clear Lake, and on the south shore of Manitowish Lake (Macholl, J.A, 2007). The extent of spring and other groundwater inputs to the reservoir can be roughly estimated by looking at the winter base flow over the dam. During frozen conditions, water levels are stable and there is no water loss from transpiration (the process of plants taking up water), evaporation, or water withdrawals. During this time, the water inputs come almost entirely from groundwater. On average, 120-150 cfs is passed over the dam during frozen conditions. Although groundwater inputs do not quickly fluctuate, they will vary based on dry or wet weather patterns. Winter base flow during drought years has averaged about 90 cfs.

<u>Water Loss from the Chain of Lakes and River Downstream of the Dam</u>
The major sources of water loss from the Chain of Lakes and downstream flows include water withdrawals for cranberry operations, private irrigation, evaporation, and plant transpiration.

Private Irrigation and Cranberry Operations
There are a number of water withdrawal structures and wells on the Chain that are likely used for watering lawns, drinking water, and other private uses. The amount of water diverted from the Chain and the river downstream for these uses would be very difficult to determine and is not known.

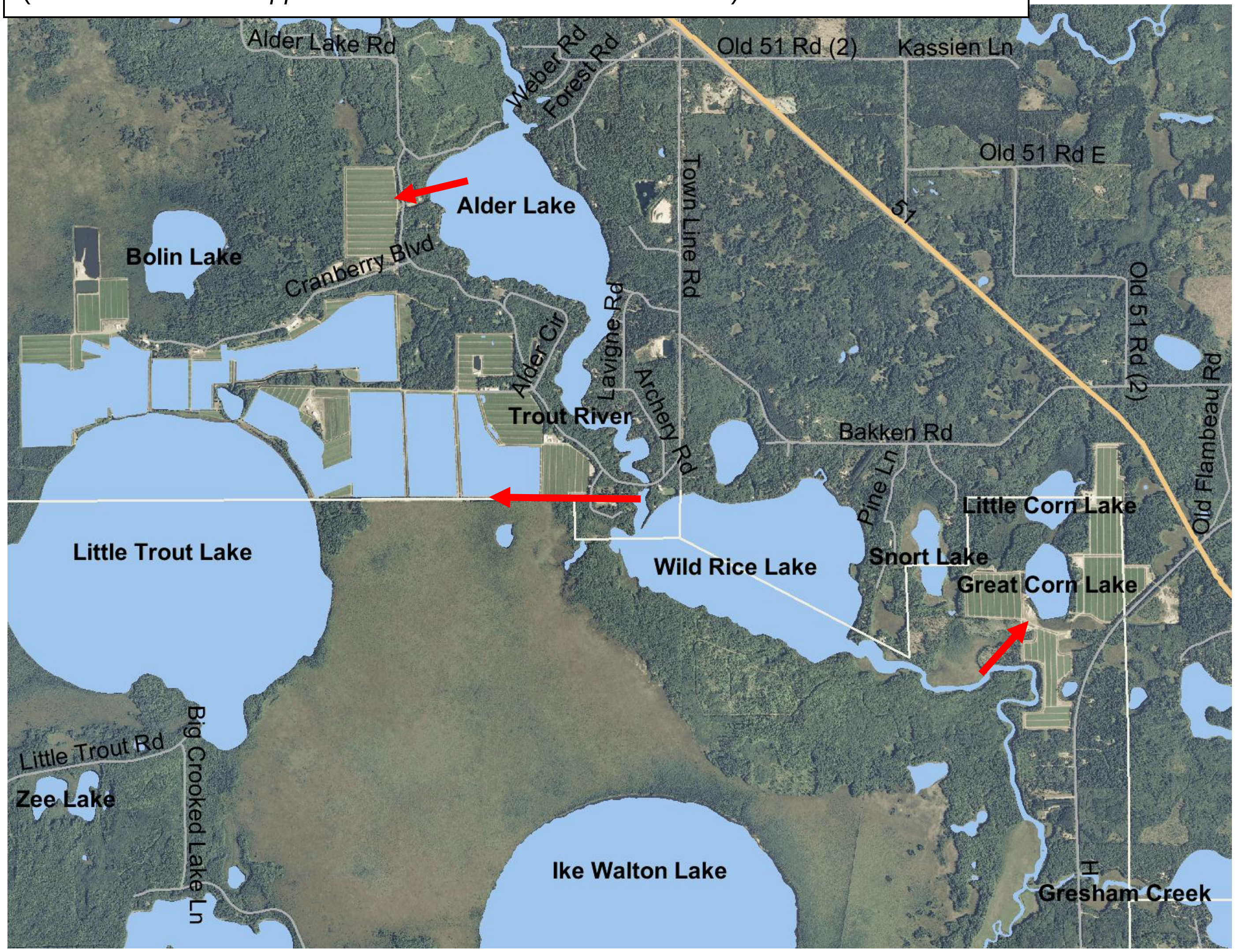
Cranberry production uses water to irrigate cranberries during the growing season, to flood beds for harvest in August, to flood beds in winter to protect the vines from freezing/drying, and to either flood beds or irrigate to protect the plants from frost in the spring. Current cranberry production practices can use substantial quantities of water, especially when flooding beds. Pumping and storing water in surface water lakes as opposed to using water directly on the cranberry beds results in a large amount of water being diverted from the Chain, especially in dry years.

There are currently three locations where local cranberry producers take water out of the Chain of Lakes and the river flows downstream of the dam. Water withdrawals take place at the following locations (shown as red arrows on Figure 9):

- Downstream of Wild Rice Lake where water is pumped to Little Trout Lake
- Upstream of Wild Rice Lake where water is pumped to Great and Little Corn Lakes
- Alder Lake where water is pumped directly to the cranberry beds

There is also a new cranberry operation that is currently under construction in the watershed that will have approximately 20 acres of cranberry beds. This operation will divert water from Lower Gresham Lake. The outlet of this lake is Gresham Creek which is a tributary to the Trout River upstream of Wild Rice Lake. Water will be pumped directly to cranberry beds and the water, minus losses due to evaporation and evapotranspiration, will be recycled back into Lower Gresham Lake.

Figure 9. Location of Cranberry Operations near Little Trout and Corn Lakes (*red arrows indicate approximate locations of water diversions*)**.**



The largest cranberry pumping location is downstream of Wild Rice Lake where the water diversion is used to keep water levels high on Little Trout Lake (Figure 10). From Little Trout Lake, the water is then pumped or flowed to individual cranberry beds. There are approximately 960 acres of cranberry production adjacent to little Trout Lake. Water diverted to these cranberry beds is likely not returned to the Manitowish Chain because it is located in the Bear River sub-watershed. The pumping station is only operated when water levels on Little Trout Lake are low during dry years. In 2007, for example, a year with very little precipitation, operating records indicate that pumping occurred 24 hours a day from June to October. In 2008, which

Figure 10. Aerial View of Cranberry Beds and Little Trout Lake

was dry but not as dry as the previous year, the pump was run 24 hours a day from August to late September. Based on the capacity of their pumps, 10 to 14 cubic feet per second of water was diverted at a time when the Chain and its tributaries were experiencing stress from drought. During the 2007 drought, USGS estimated the following inflows and the percent of flow that was diverted with the 10 to 14 cfs pumping rate from this operation. The amount of water withdrawn from the Chain and diverted to Little Trout Lake ranged from 11 to 27% of the natural inflow (Table 4).

Table 4. Little Trout Lake Cranberry Water Diversion in 2007

Month	Inflow (cfs)	% of inflow diverted with pumping	Water Available for Chain storage (*inflow minus 40 cfs minimum flow*)
June	88	11 to 16%	48 cfs
July	74	14 to 19%	34 cfs
August	64	16 to 22%	24 cfs
September	53	19 to 27%	13 cfs

Another cranberry pumping location is upstream of Wild Rice Lake where the water diversion is used to keep water levels high on Great and Little Corn Lakes. There are approximately 177 acres of cranberry production in this location. Since it is unknown how much water is lost to evaporation and evapotranspiration, and unused water is directly and indirectly (through groundwater recharge) returned to the reservoir, it is difficult to determine what effect these operations have on water levels on the Chain and the river downstream of the dam. The effects of pumping at this location were observed by interpreting USGS data at a gage placed just downstream of the cranberry pumping location. It was determined that this cranberry operation diverts from 2 to 100 percent of the flow of the Trout River when the pumps are turned on. For example, on December 11, 2009, USGS measured 2.41 cfs below the pumps and 25.0 cfs upstream (a diversion of 22 cfs). This means that under low flow conditions, the pumping rates can and were measured by the USGS gage to temporarily reverse the direction of flow on the Trout River. The pump at this location cannot be operated continually because the pump exceeds the capacity of the river to provide water. Because of this, the pump is turned on for a period of time and is then turned off so that the Trout River can recover. In a 24 hour period, considering the time the pumps are turned on and off, a review of pumping records indicates that this operation pulls 3 to 8 cfs per day on average. The water from this operation, minus losses due to evaporation and evapotranspiration, is recycled back into the Manitowish system via direct discharge and ground water flow. The quantity of water diverted and the delay in returning it to the river at this location is expected to have an impact on aquatic life and habitat in the area immediately adjacent to this pumping area.

In total, when the pumps are operating at the two largest cranberry operations described above, up to 37 cfs can be instantaneously withdrawn from the Trout River inflows to the Chain of Lakes. Since the pumps that divert water to the Corn Lakes are turned on and off, on a daily average basis, total pumping rates at both of the large cranberry operations have averaged 13 to 22 cfs. These cranberry water withdrawals, along with the minimum flow of 40 cfs passed over the dam, was greater than the inflows coming into the Chain during the 2007 drought.

The third cranberry farm is much smaller compared to the Little Trout and Corn Lakes operations and has approximately 41 acres of cranberry beds. This operation takes water out of Alder Lake and recycles water directly back to where it was withdrawn minus losses due to evaporation and evapotranspiration. The fourth operation has not yet been fully constructed and is not operating at this time.

The Department has no regulatory authority over the removal of water from public waterways for cranberry operations. Section 94.26 Wisconsin Statutes reads "*Cranberry culture; maintenance of dams, etc. Any person owning lands adapted to the culture of cranberries may build and maintain on any land owned by the person such dams upon any watercourse or ditch as shall be necessary for the purpose of flowing such lands, and construct and keep open upon, across and through any lands such drains and ditches as shall* *be necessary for the purpose of bringing and flooding or draining and carrying off the water from such cranberry growing lands, or for the purpose of irrigation, fertilization and drainage of any other lands owned by the person; provided, that no such dams or ditches shall injure any other dams or ditches theretofore lawfully constructed and maintained for a like purpose by any other person.*" Further a footnote in Section 30.18 Wisconsin Statutes which regulates water diversions "*exempts cranberry growers from permit requirements*".

Evaporation and Transpiration
The rates of evaporation and plant transpiration are variable and are dependent on environmental factors such as temperature and time of the growing season (Lenters, et. al. 2005). The amount of water lost through plant transpiration is difficult to estimate and is not known. The Wisconsin Valley Improvement Company (WVIC) has conducted studies to help estimate evaporation rates on Northern Wisconsin reservoirs. Their studies show that during the summer, evaporation rates can be as high as 4-6 inches of water surface elevation decrease per month. Five inches of evaporation in one month on the Manitowish Chain (~4,100 acres) is equivalent to 28 cfs of water leaving the Manitowish River system in that time period. Another aspect of the water budget that is difficult to determine without extensive study is groundwater discharge and recharge. Groundwater movement is based on many factors including long term weather patterns and groundwater table fluctuations, as well as the height of surface water in the reservoir. Evaporation loss and groundwater inputs were estimated by USGS to essentially cancel each other out resulting in no net water loss or gain as part of their analysis. These aspects of the water budget are described in detail in the USGS report in Appendix II.

<u>Reservoir Water Storage</u>
At the 5' 0" elevation, there are 8,035 acre-feet (350 million cubic feet) of water held in the Chain, and at the 8' 6" elevation there are 23,186 acre-feet (1,010 million cubic feet) of water held in the Chain. Therefore, under current operations, the reservoir capacity of the Chain is 15,151 acre-feet (660 million cubic feet) of water. Downstream, the Turtle Flambeau Flowage is raised about 11 inches during the fall drawdown of the Rest Lake Chain. Based on USGS estimates, to raise or lower the Chain 1 inch takes 14.8 million cubic feet of water. This amount of water translates to a daily flow of 171 cubic feet per second that is either taken from, or added to river flows downstream of the dam.

<u>Water Quality</u>
Water quality of the Manitowish River system is generally good. A review of baseline water quality monitoring data indicates that environmental variables (Chlorophyll A, nutrients, and water clarity) of lakes within the Manitowish Chain are similar to other lakes in Northern Wisconsin with good water quality (Lillie and Mason, 1983). Water quality is affected by Mercury (Hg) which is a naturally occurring element released into the atmosphere through both natural processes and industrial air pollution. In aquatic systems, methylmercury (MeHg) is the primary form of mercury that enters the food chain and is also the major form that bioaccumulates in predatory game fish species. Bioaccumulation means that a chemical is able to accumulate at a faster rate than the body can eliminate it, and over time levels continue to increase. The other component of bioaccumulation is that there is an incremental increase in contamination levels at each level of the food chain. This effect is compounded the longer an organism lives. Certain species, such as larger predatory game fish, will likely have the highest mercury levels. There are a number of factors that influence the concentrations of mercury found in the predatory game fish in a particular lake. Because of the human health concerns related to mercury, in 2004 the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) tested the levels found in predatory game fish on eight lakes on the Manitowish Chain. The mercury levels found were not high enough for the DNR to specify fish consumption advisories specific to these lakes, but the general statewide fish consumption advisory applies. In 2006 GLIFWC published more restrictive fish consumption advisories for some of the lakes on the Manitowish Chain. Additional information about the GLIFWC mercury maps can be found online at:
http://www.glifwc.org/Mercury/mercury.html

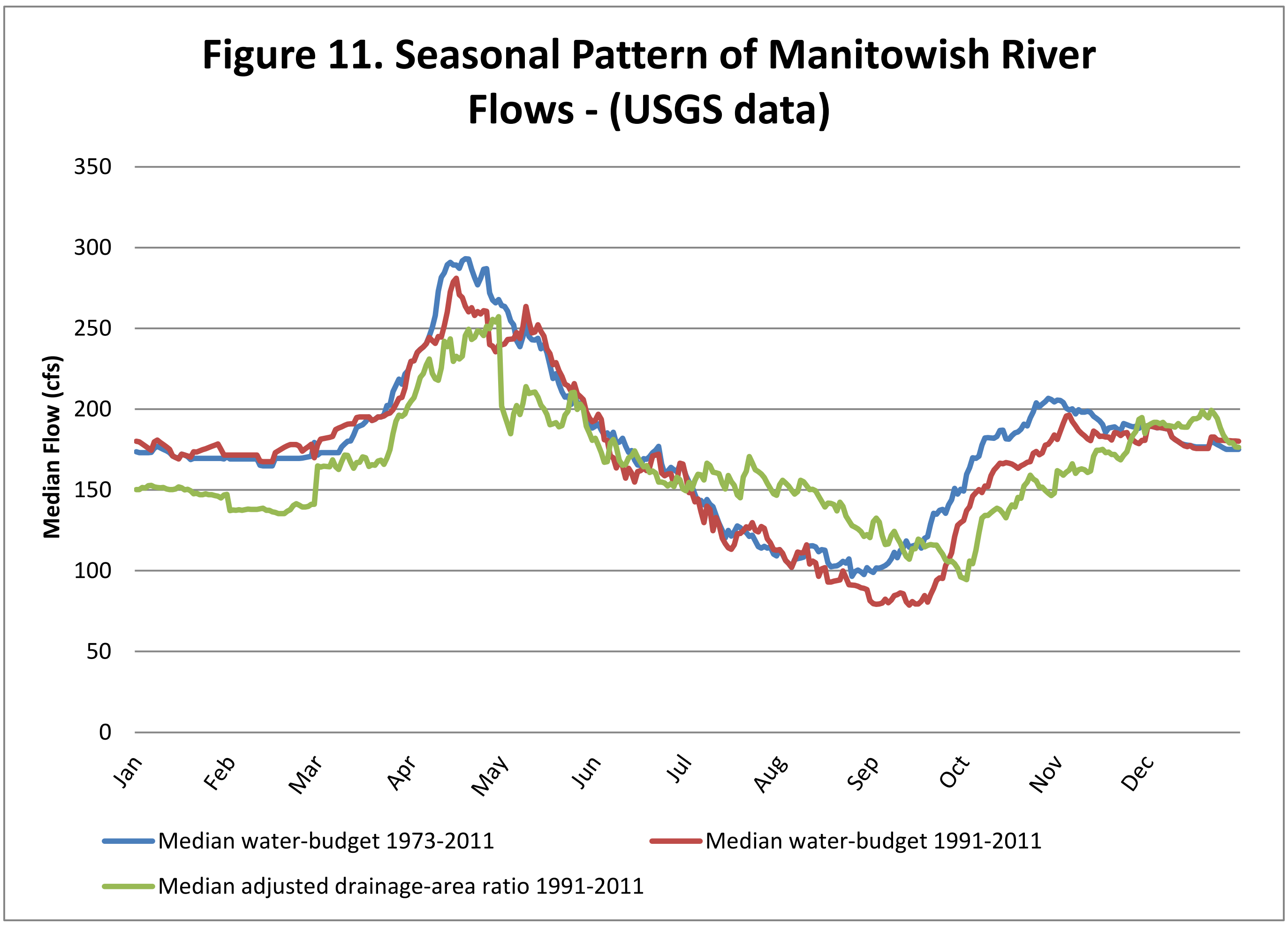
<u>Natural Pattern of Water Levels in the Manitowish Chain of Lakes</u>
Most of the lakes on the Chain (with the exception of Clear lake) can be characterized as surface water

flow-through lakes. Long term gaging by USGS has shown that these lakes naturally experience seasonal lake level fluctuations (House, 1985). Surface water flow-through lakes can be expected to experience short term fluctuations following snowmelt or large storm events. The highest water levels generally occur in April, May, and June.

Natural Pattern of Manitowish River Flows

The natural annual flow pattern of Northern Wisconsin rivers is characterized by high flows in the spring, when rain events often combine with the melting snowpack. The high spring flow periods were often called the “spring freshet” in the current and historic operating orders. Based on information provided by Wisconsin Valley Improvement Company staff who have studied many years of river hydrographs, March 25th is the average date for spring runoff in the Northwoods, and 75% or more of spring runoff has passed by April 15th. Over late spring and summer months, river flows gradually decrease with some fluctuations occurring as a result of storm events. The lowest flows of the season are generally found in late summer or early fall. In late fall, flows generally increase with more rain and less water loss through evaporation and plant transpiration, and stabilize over the winter months when inflows are primarily groundwater inputs.

Since there are no long term records or gages recording inflows into the Chain, the natural historic flow pattern (i.e. the hydrograph) for the Manitowish River at the Rest Lake Dam was modeled by the USGS (figure 11).



Two methods were used to estimate these flows. The first method involved placing stream gages upstream of the reservoir that measured inflows from 2009 to 2011. This data was tied to two local long-term gaging stations. Using a regression analysis that related stream flow divided by the watershed area, the natural flows for the Manitowish River from 1991 to 2011 were calculated. The second method USGS applied was a water budget approach which used water level and discharge data provided by Xcel Energy to estimate natural inflows. This model was used to compute the natural flow at the dam from 1973 to 2011. The USGS study revealed that natural flows of the Manitowish River system exhibit a similar seasonal pattern as described above with high spring flows followed by low flows in late summer. The median historic natural flows are shown on Figure 11. The full USGS report can be found in Appendix II.

Throughout this document it is important to note that river flows will be described as “flows reported by Xcel” or “flows measured by DNR”. River flows measured by USGS or DNR were routinely higher compared to the discharge recorded by Xcel on the same day. DNR measures river flows by measuring the velocity of water flowing through a measured cross-section of the Manitowish River below the USH 51 crossing. In the past, flows reported by Xcel were likely underestimated since dam leakage rates through boards and through groundwater have not been closely studied. Leakage rates likely vary and are expected to be highest when there is the greatest head (e.g. when the reservoir is at the maximum water level). Department of Transportation (DOT) soil borings at the bridge indicate the dam is located on top of cobbles and boulders and this type of substrate likely allows groundwater movement underneath the dam. In 2010, the DNR and Xcel Energy met to try to determine why Xcel discharge estimates were consistently lower compared to DNR and USGS measurements. DNR and USGS measured flows were consistently very close to each other. To improve the accuracy of Xcel discharge estimates, new stop logs were installed at the dam that were uniform in size and had fewer gaps between boards. More recently, a lift gate and a new stop log lifting hoist were installed at the dam which should further improve the accuracy of flows reported by Xcel. The relationship between DNR measured flows, USGS measured flows, and the reported discharge at the dam is described in detail in the USGS report.

5. Biological Environment (dominant aquatic and terrestrial plant and animal species and habitats including threatened/endangered resources; wetland amounts, types and hydraulic value)

<u>Aquatic Habitat Above the Rest Lake Dam</u>
The one foot contour maps of the lakes on the Chain along with aerial photos taken at a range of water levels provide useful information to show the extent, location, and type of open water aquatic habitat. The major types of aquatic plant and animal habitat affected by the operation of the dam include the aquatic bed littoral zone (the area of a lake where light can penetrate and aquatic plants grow) and wetlands within and adjacent to the 3.5 foot draw down zone. Based on USGS calculations, there are about 656 acres of surface water resources dewatered when the Chain is lowered 3 feet. The lake contours are not accurate enough to be able to estimate the additional area dewatered at the full 3.5 foot drawdown water level. The locations and extent of lakebed that is currently dewatered at the 3.5 foot drawdown can be seen by following the 3 foot contour on the lake maps for each lake in the Chain (Appendix III).

Aquatic Bed Lake Littoral Zone
The littoral zone is the area on a lake that is shallow enough for enough light to penetrate to support the growth of submergent (entirely underwater) and emergent (partially underwater and extending above the water surface) aquatic plants. Aquatic plant surveys on Rest Lake, Papoose Bay, Wild Rice Lake, Island Lake, and Rice Creek revealed that the species richness on each of these lakes ranged from 25 to 42 species. No endangered, threatened, or special concern species were recorded on these lakes. Curly leaf pondweed, an invasive species, has recently been documented in Rice Creek and Island Lake. On Rest Lake and Wild Rice Lake, the density and distribution of aquatic plant species were studied. Papoose Bay (part of Rest Lake) has a muckier lake bottom and constant water flow from Papoose Creek. Because of these differences, the common plant species lists were kept separate for each area. The five most common species on these two lakes are as follows:

- Rest Lake: Common Waterweed or Elodea *(Elodea canadensis),* Fern Leaf Pondweed *(Potamogeton robbinsii),* Northern Water Milfoil (*Myriophyllum sibiricum),* Wild Rice *(Zizania palustris), and* Bushy Pondweed or Naiad *(Najas flexilis).*

- Papoose Bay: Muskgrass (*Chara),* Wild Rice*,* Elodea*,* Northern Water Milfoil*,* and Water Marigold *(Bidens beckii).*
- Wild Rice Lake: Fern Leaf Pondweed*,* Coontail (*Ceratophyllum demersum),* Naiad*,* Elodea*,* and Northern Water Milfoil.

The Floristic Quality Index (FQI) was determined for each lake. The FQI is an index meant to compare the overall floristic quality of a lake for comparison among many sites and for tracking change at a specific site over time. This assessment method is based on the sensitivity of different plant species to tolerate disturbance and reduced water quality. The FQI for the Chain was high, scoring 30.86 to 41.9, and is greater than what Nichols found for flowages in the region (mean of 28.3). These scores are consistent with the baseline water quality monitoring data discussed previously.

There were differences in plant abundance and distribution between the lakes. On Rest Lake the maximum water depth that plants were found was nearly 12 feet, and within the zone of plant growth, 18% of sample points had vegetation. Wild Rice Lake had a maximum water depth of plant growth of 13 feet, and on that lake, 95% of the sample points had vegetation. Island Lake had a maximum water depth of plant growth of 10 feet, and within the zone of plant growth, nearly 26% of sample points had vegetation. The difference in plant density between the four areas is likely due to differences in the composition of the lakebed. The lakebed of Rest Lake is primarily sand and gravel that does not support dense plant growth while the lakebeds of Papoose Bay and Wild Rice lakes have more muck and organic material that can support dense stands of aquatic plants. The substrate of the littoral zone in Island Lake is somewhat evenly split between muck and sand/rock. The sample locations with higher densities of aquatic vegetation were predominantly muck. Although the other lakes on the Chain were not studied in detail, Clear, Alder, Manitowish, Little Star, Stone, and Spider Lakes likely have plant communities and densities similar to Rest Lake. Fawn Lake and the inlets of the Manitowish River and Rice Creek likely have plant communities and plant densities similar to Wild Rice Lake and Papoose Bay.

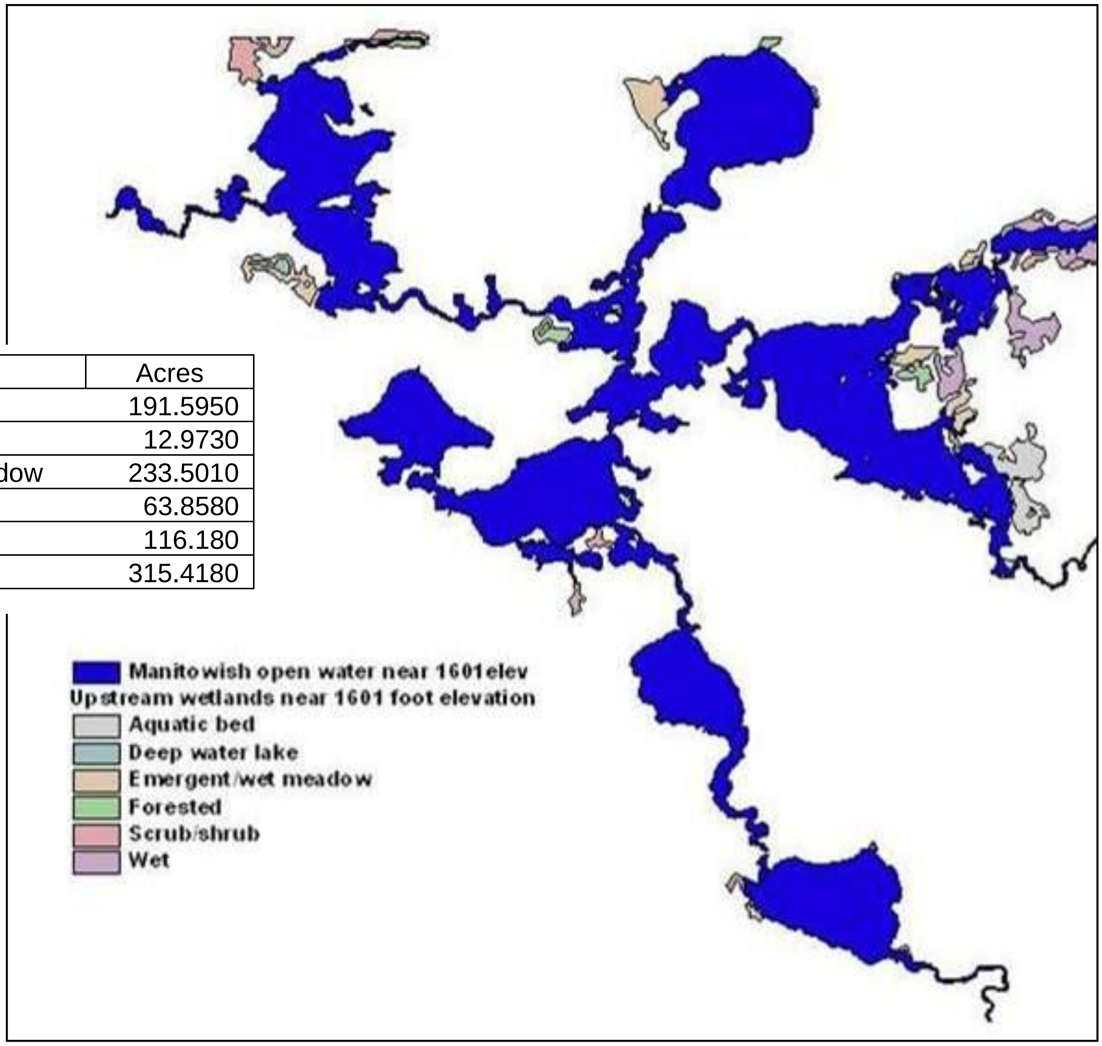
The portion of the littoral zone that is directly affected by the current operation of the dam is from the water's edge (at the full pool water level 8' 6"), to a depth of 3.5 feet. This zone becomes exposed lakebed during the current winter drawdown of the Chain and is subject to atypical annual freeze and thaw conditions for aquatic habitats. Since the lake bottom is periodically dewatered, the drawdown zone may also have reduced organic matter accumulation which may in-turn contribute to lower plant densities than would be expected if water levels remained constant. Areas that are repeatedly dewatered also tend to be dominated by annual pioneer species. Of the common plant species for each of the lake areas summarized above, the following list includes the plant species that exist in the drawdown zone:

- Rest Lake: Elodea*,* Wild Rice*,* and Naiad*.*
- Papoose Bay: Muskgrass*,* Wild Rice*,* Elodea*,* and Water marigold*.*
- Wild Rice Lake: Elodea and Naiad.
- Island Lake: Naiad, Water marigold, Small pondweed *(Potamogeton pusillus)*, Clasping leaf pondweed *(Potamogeton richardsonii)*, and Wild celery *(Vallisneria Americana).*
- Rice Creek: Wild Rice, *Nitella* sp., and Elodea

Wetlands Upstream of the Dam

There are approximately 934 acres of mapped wetlands on the Wisconsin Wetland Inventory (Figure 12) that are in the current drawdown zone or connected to the Manitowish Chain of Lakes. The Wisconsin Wetland Inventory mapping is completed through interpretation of highly precise aerial photos by trained experts to determine which areas appear to be wetlands. Some wetlands can be missed through this procedure, especially wetlands smaller than 5 acres. Also, some field verifications done both upstream and downstream of the dam have shown that not all wetland types are accurate mapped. Land survey records from the 1800's and the tree stumps that can still be seen in many of the wetland areas on the Chain all suggest that the creation of the dam substantially altered the historic natural wetland hydrology and plant communities.

Figure 12. Wisconsin Wetland Inventory on the Chain of Lakes



Class	Acres
Aquatic Bed	191.5950
Deep Water Lake	12.9730
Emergent / Wet Meadow	233.5010
Forested	63.8580
Scrub / Shrub	116.180
Wet	315.4180

Today, wetlands below the full-pool high water elevation can be described as aquatic bed wetlands that are periodically dewatered. With the current 3.5 foot winter drawdown, these wetlands are dewatered at the winter drawdown level (5' 0") and are flooded at the full pool elevation (8' 6") (Figure 13). Many of the aquatic plants found in this area are outlined in the Aquatic Bed Lake Littoral Zone section above. The wetland areas along the edge and adjacent to the full-pool water level can be described as emergent wet meadows. These wetlands have persistent vegetation with very saturated soils or shallow water at the 8' 6" water level. Fresh meadows typically represent younger plant communities that can tolerate disturbances such as drainage, siltation, cultivation, pasturing, peat fires, or temporary flooding (Minnesota Pollution Control Agency, 1997). Several of the dominant plant species in these wet meadow wetlands, such as lake sedge, bulrushes, and Pennsylvania bittercress, are associated with fluctuating water conditions. Other common plant species include cattails, wild rice, bur-reed, Canada bluejoint, three way sedge, water lily, and spike-rushes. Reed canary grass and purple loosestrife are present in many of the wetland areas but these invasive species have not been observed to be the dominant plant species at any site. The scrub/shrub wetland areas on the Chain of Lakes are generally limited to the non-flooded wetland fringes. The shrubs present include tag alder, leatherleaf, and sweet gale. Forested wetland areas are also generally limited to higher elevations that are not flooded during the 8' 6" water elevation. Common wetland tree species present are balsam fir, white pine, and white birch.

Figure 13. Shallow aquatic bed wetlands on Island Lake at the (8’ 6”) water level.

The wetlands on the Chain provide important habitat for foraging, nursery, spawning, cover, and other uses for the diverse assemblage of fish, wildlife, and other aquatic organisms that will be described in detail later in the analysis. On the Chain of lakes, important wetland habitat areas include the following locations: the north end of Rest Lake where Papoose Creek enters, the fringe of Fawn and Wild Rice Lakes, Island Lake where Rice Creek and the Manitowish River enters, and the marsh areas between Manitowish and Alder Lake. In addition to providing important aquatic habitat, these wetlands also provide other important ecological functions such as flood storage retention, water quality protection, scenic beauty, and shoreline protection.

Aquatic Habitat Below the Dam

The tail water elevation at the Rest Lake dam is 1591.5 and the elevation of the River is 1575.0 at the confluence of the Bear River according to USGS topographic maps. This drop in elevation corresponds to an average of a 1 foot drop per river mile. Important types of aquatic fish and wildlife habitat downstream of the dam that are affected by the timing and magnitude of flows on the river include: shallow rocky riverbed areas with moderate to swift current, oxbow and backwater areas, and riparian wetlands.

The river can be separated into two distinct sections based on the river gradient (e.g. the drop in the river elevation per mile of river). The first four river miles below the dam have a higher gradient with faster water velocities, a limited wetland fringe, and forested river banks that quickly rise above the floodplain elevation (Figure 14). This section has a sand dominated river bottom composition with a few areas dominated by more gravel, cobble, and boulders.

Figure 14. Aerial Photo of the High Gradient Section of the Manitowish River with steeper banks and a narrow wetland fringe.

Rocky River Bottom Habitat

Stretches of river in this high gradient section have a rocky substrate with moderate to swift current. This type of river habitat (Figure 15) is very limited between the dam and the Turtle-Flambeau flowage. The area below Highway 51 is considered high quality, critical habitat for a number of fish species that require this type of habitat for spawning. Rocky habitat can also be found above Sturgeon Lake and at the confluence of the Manitowish and Bear rivers.

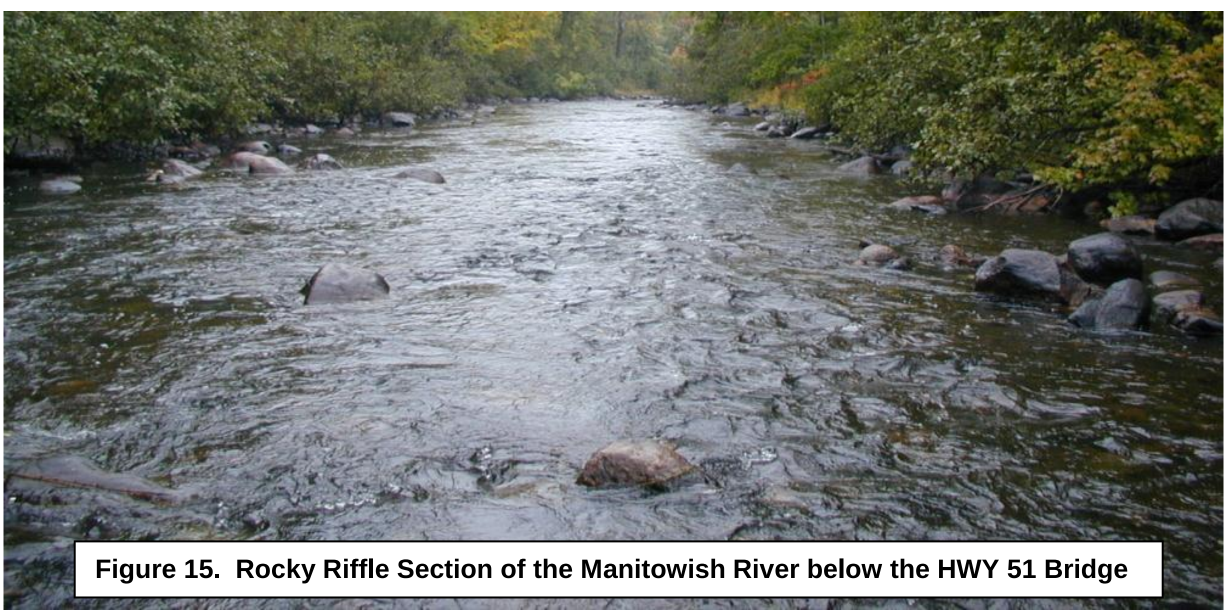


Figure 15. Rocky Riffle Section of the Manitowish River below the HWY 51 Bridge

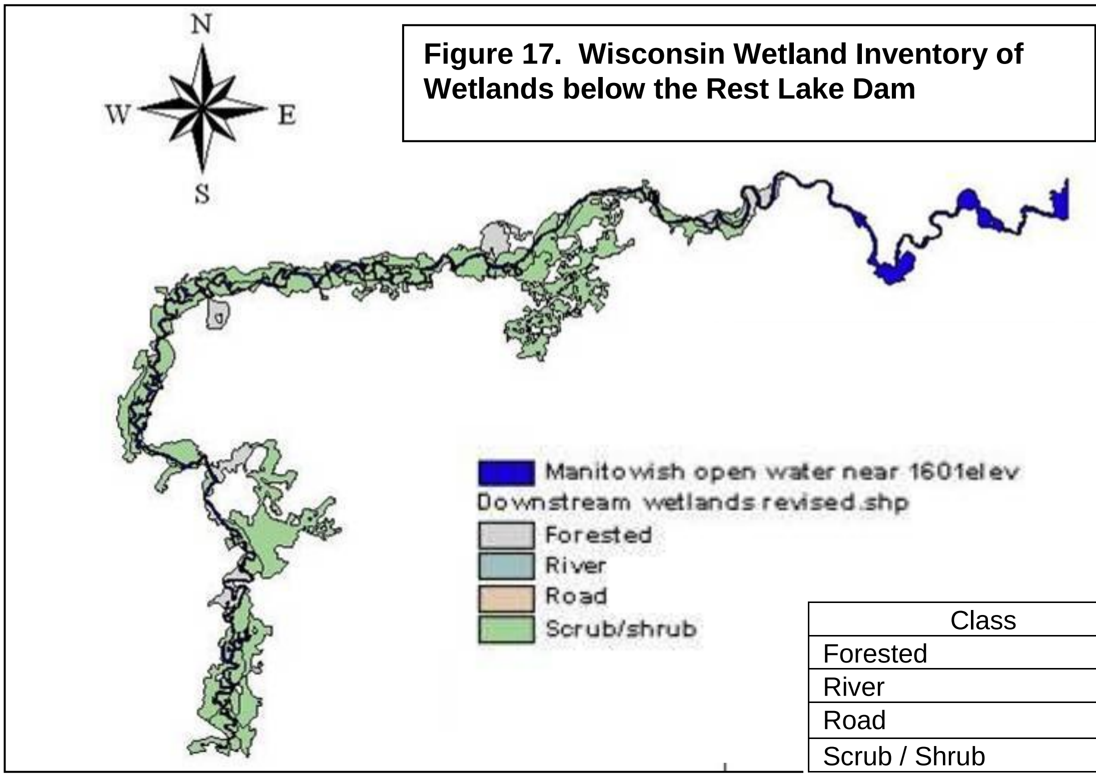
Comparatively, from about four river miles below the dam to the Turtle Flambeau Flowage, there is less gradient (drop in river elevation per mile) and the river becomes sandier. This section of the Manitowish River has the characteristics of an alluvial river system. These types of rivers continually change their course by cutting through and redistributing sediment in the floodplain, natural levees are deposited at the side of the channel, and contain numerous pools, meanders (bends in the river), oxbows (old river channels), backwater sloughs, and wetlands connected to the river (Figure 16).

Figure 16. Low Gradient Section of the Manitowish River with Riparian Wetlands and Oxbows.

Riparian Wetlands Below the Dam
The land survey records from the 1800's indicate that the wetlands along the Manitowish River downstream of the dam have also undergone substantial changes over the last 145 years. Although there are limited reference points, the wetlands along the river were originally described as tamarack and black spruce swamps and as "low and swampy" areas. There are currently, approximately 1,558 acres of wetlands mapped on the Wisconsin Wetland Inventory that are connected to the Manitowish River below the dam as shown on Figure 17 below.

Based on DNR staff observation and surveys in these areas, the wetlands below the Rest Lake Dam can be characterized as wet meadow, scrub-scrub, aquatic bed, and forested wetlands. The areas identified as shrub/shrub on the wetland inventory map above are actually a mosaic of meadow and scrub-shrub wetlands. These patches of wet meadow areas are adapted to tolerate inundation of water for periods of time that inhibits the growth of wetland shrubs and trees. These areas flood more frequently and are generally found adjacent to the main river channel (Figure 18). Currently, many species found in the wet meadow areas have the ability to adapt to fluctuating water levels such as Canada bluejoint grass, lake sedge, rush species, tussock sedge, yellow pond-lily, bur reed, soft stem bulrush, and hard stem bulrush. There are areas of well-established reed canary grass patches established throughout the riparian river corridor. Although there are some patches that are dominated by this invasive, native species are dominant in most wet meadow wetland areas. Purple loosestrife is also established along the river corridor and is currently found two miles downstream and one quarter mile upstream of the Highway 47 Bridge. It is currently found as single plants or in small numbers along the steeper portions of the river bank and there are also approximately 10 to 20 patches of about 0.1 acres in shallow backwater areas. Annual control efforts take place to keep the population of purple loosestrife low along the river corridor.

Figure 17. Wisconsin Wetland Inventory of Wetlands below the Rest Lake Dam



Class	Acres
Forested	155.9880
River	3.809
Road	0.6410
Scrub / Shrub	1397.6000

Historic aerial photos and observations made by local people that are familiar with the river suggest that over the last 50 or 60 years, the wetland plant community downstream of the dam has gradually changed from a wetland dominated almost entirely by wet meadows to a wetland dominated with scrub/shrub species in many areas. These wetland areas flood less frequently than the meadow areas and are dominated by shrub species such as tag alder, willow, and meadowsweet. The understory in these areas is composed of grasses and sedges such as Canada bluejoint, lake sedge, and tussock sedge.

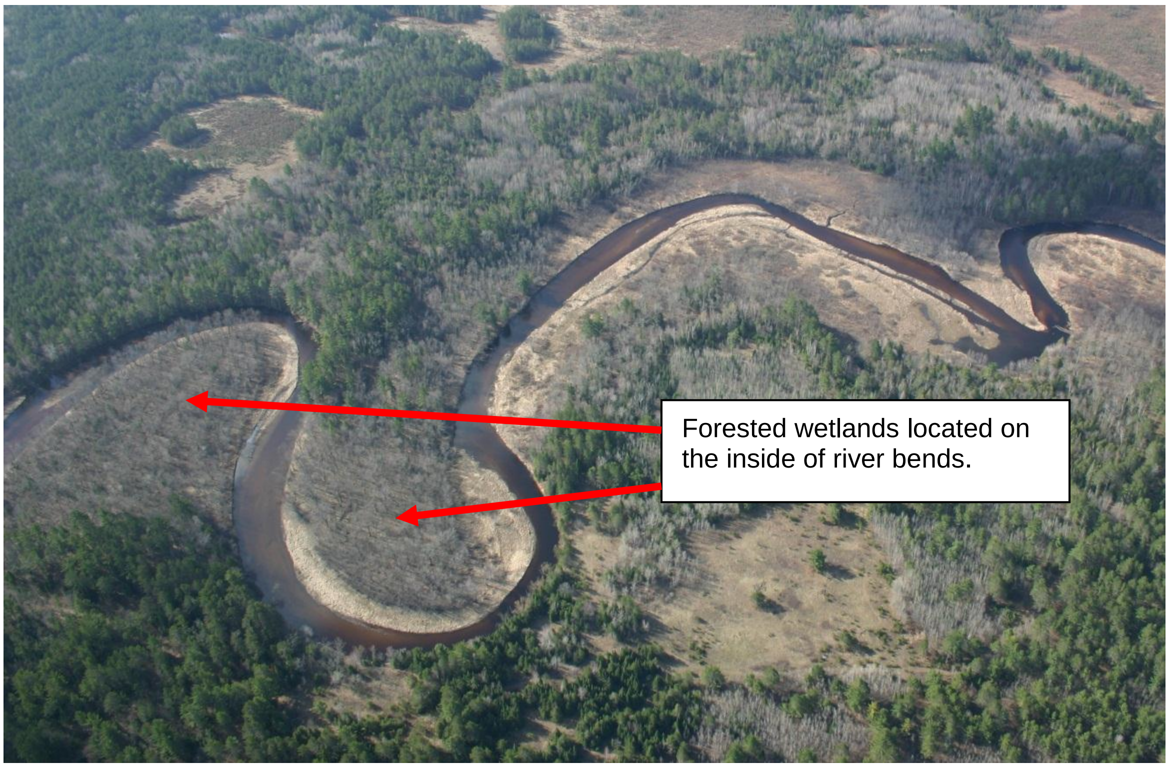
Figure 18. Wet Meadow and Scrub/Shrub Wetlands

The aquatic bed wetlands are not identified on the Wisconsin Wetland Inventory Maps. These areas are comprised of the oxbow channels and backwater sloughs that are found along the river corridor in the lower gradient alluvial sections of the river (Figure 16). These wetlands are in the deeper portions of river oxbow and backwater areas that hold water during both high and low flows. Vegetation is a mosaic of both emergent and submergent vegetation. These wetland areas are dominated by floating leaf, submergent plants, and emergent plants including duckweed, coontail, spatterdock, water horsetail, and water smartweed. On the fringes of these areas, with shallower water depths, the sloughs and oxbows transition into emergent aquatic communities with plants like bulrush, bur-reed, arrowhead, marsh cinquefoil, lake sedge, river sedge, spike-rush, and pickerel weed. The picture below shows an oxbow wetland area under high flow river conditions (Figure 19).

Figure 19. River Oxbow Wetland (October 2009, Flow at 322 cfs – Water Depth = 29 3/8", DNR Measured)

Forested wetlands are the other major type of wetland located along the river below the dam. There are many areas of this wetland type along the Manitowish River that are not shown on the Wisconsin Wetland Inventory map. Forested wetlands are dominated by mature, deciduous hardwood trees growing on alluvial soils and are often associated with riverine systems. Along the Manitowish River, the forested wetlands are located in the depositional areas (areas where river sediment deposits during flood events) on the inside of river bends (Figure 20). These areas are inundated during flood events but are usually somewhat well drained for much of the growing season. Plant species typically include silver maple, green ash, river birch, American elm and black willow.

Figure 20. Floodplain forest along the Manitowish River.



The wet meadow, scrub/shrub, oxbow, and floodplain forest wetlands are valuable ecosystems that provide feeding, spawning, cover and other life history needs for the wide range of fish and wildlife species that will be described in the following section of this analysis. These riparian wetlands also provide flood storage retention, protect shorelines, and provide water quality protection, and provide opportunities for recreational and scenic beauty.

Functions and Values of the Wetlands Above and Below the Dam

As summarized on the WI DNR website, wetlands have a number of important functions and values. The wetlands above and below the dam have the potential to support an abundance and variety of plants. These plants contribute to the earth's biodiversity and provide food and shelter for many animal species at critical times during their life cycles. Many of the rare and endangered plant species in Wisconsin are found in wetlands. The importance of floral diversity in a particular wetland is usually related to two factors. First, the more valuable wetlands usually support a greater variety of native plants (high diversity), than sites with little variety or large numbers of non-native species. Second, wetland communities that are regionally scarce are considered particularly valuable.

Many animals spend their whole lives in wetlands; for others, wetlands are critical habitat for feeding, breeding, resting, nesting, escape cover or travel corridors. Wetlands are spawning grounds for northern pike, nurseries for fish and ducklings, critical habitat for shorebirds and songbirds and lifelong habitat for some frogs and turtles. Wetlands also provide essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, insects, and plankton. Some of the most valuable wetlands for fish and wildlife provide diverse plant cover and open water within large, undeveloped tracts of land that exist both upstream and downstream of the dam. The fish, wildlife, and other aquatic organisms that are associated with these wetland areas will be described in greater detail in the following section of this analysis.

Due to dense vegetation, soil absorption capabilities, and location within the landscape, wetlands are important for retaining stormwater from rain and melting snow rushing toward rivers and lakes, floodwater from rising streams. Wetlands slow stormwater runoff and can provide storage areas for floods, thus minimizing harm to downstream areas.

Wetland plants and soils have the capacity to store and filter pollutants ranging from pesticides to animal wastes. Calm wetland waters, with their flat surface and flow characteristics, allow particles of toxins and nutrients to settle out of the water column. Plants take up certain nutrients from the water. Other substances can be stored or transformed to a less toxic state within wetlands. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer. Larger wetlands and those which contain dense vegetation are most effective in protecting water quality.

Shoreland wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. Roots of wetland plants bind lakeshores and streambanks, providing further protection. Benefits include the protection of habitat and structures, as well as land which might otherwise be lost to erosion. This function is especially important in waterways where boat traffic, water current and/or wind cause substantial water movement which would otherwise damage the shore. A wetland which reduces erosion can also reduce sedimentation to nearby waterways. If the waterway is a navigational channel, the reduction in sedimentation can help reduce the frequency of dredging to maintain the channel.

Groundwater recharge is the process by which water moves into the groundwater system. Although recharge usually occurs at higher elevations, some wetlands can provide a valuable service of replenishing groundwater supplies. The filtering capacity of wetland plants and substrates may also help protect groundwater quality. Groundwater discharge is the process by which groundwater is discharged to the surface. Groundwater discharge is a more common wetland function and can be important for stabilizing stream flows, especially during dry months.

Wetlands are also popular places to study, hike or just observe. They provide peaceful open spaces and have rich potential for hunters and anglers, scientists and students. Wetlands provide exceptional educational and scientific research opportunities because of their unique combination of terrestrial and aquatic life and physical/chemical processes.

Fisheries of the Rest Lake Reservoir

A review of historic WDNR survey files and more recent survey work conducted on the Chain between 2002 and 2005 indicates that 35 species of fish have been documented on the Chain of Lakes. A list can be found on Table 5. Two species (found both above and below the dam), the greater redhorse and the pugnose shiner, are state threatened species that are discussed in a separate section below focusing on scarce resources.

Fish Associated with Cobble-gravel Lake Bottom Habitat

Walleye (*Sander vitreus)* are currently the most abundant gamefish in the Chain. In 2004, a WDNR survey determined that there were 10,418 adult walleye in the Chain (WDNR unpublished data). This is equivalent to 2.6 walleye per acre which is an average number for natural walleye waters in the area. They spawn on cobble-gravel shorelines shortly after ice out when water temperatures are between 38 and 44˚F (Becker, 1983). At this time of year, the lake levels are generally at or close to the 5' 0" winter drawdown elevation. Around June, the young of year fish move to weed edges and shallow sandy flats to feed on invertebrates.

Lake Herring (Cisco) (*Coregonus artedii)* are found throughout the Chain and are most common in the deeper lakes (WDNR unpublished data). This species is listed as a state species of special concern. Herring spawn in the fall when water temperatures fall below 43˚and peaks at around 38˚F (Becker, 1983). For northern Wisconsin this typically occurs in late November just prior to ice up. The current winter drawdown is usually complete when this species will spawn. Spawning sites are located in shallow water (3 to 10 feet) over gravel or stony substrate. Eggs are scattered over the bottom and do not hatch out until ice out the following April.

Lake Whitefish (*Coregonus clupeaformis)* are present in only a few inland lakes in Wisconsin (Lyons, et. al., 2000) and naturally sustained inland populations are rare in the U. S. This species was found during a fall 2011 seining survey of Little Star Lake (WDNR unpublished data). Four whitefish between 22 and 25 inches in length were captured along the northeast shore of the lake on the night of November 16^{th}. Little Star Lake is the deepest lake in the Chain at 67 feet and the most likely to support whitefish. Manitowish Lake which has a maximum depth of 61 feet and this lake may also have a whitefish population. There is only one other prior anecdotal report of this species occurring in Little Star Lake. This account comes from former Vilas County fisheries biologist Harland Carlson who captured 5 whitefish while seining for herring on the east shore of the lake. The fish were all between 20 and 28 inches in length. The very large size of these individuals may indicate that recruitment has been limited in recent years. The life history of whitefish is very similar to that of the lake herring. The only major difference is that they tend to spawn slightly earlier than herring at a water temperature around 46˚F (Becker, 1983). These water temperatures are typically reached in early to mid-November in Vilas County.

Although some cobble-gravel areas are within the current drawdown zone on the Chain, there is abundant habitat available through a wide range of reservoir water levels. Consequently, the operation of the dam does not appear to be a major factor affecting the habitat availability or populations of any of the species referenced above associated with this habitat type.

Fish Associated with Seasonally Flooded Aquatic Bed Wetland Habitat

Many of the species of fish found on the Chain are associated with shallow areas with submergent aquatic vegetation. These areas provide important feeding and cover habitat for the young of year of many different fish species, and non-game minnow species. Predators are commonly found in these areas because it provides an important forage base. Northern pike, muskellunge, and grass pickerel in particular require vegetated-type habitat for spawning and for survival of newly hatched and fingerlings. Northerns are one of the earliest fish to spawn in the Chain and spawning occurs right after ice out when water temperatures are between 38 and 54˚F. The Chain has a low density but quality muskellunge fishery. The lakes are currently stocked by WDNR with about 1,800 large musky fingerlings (9 to 12 inches) in even numbered years. Fall electrofishing surveys also indicate that there is limited natural recruitment occurring in the Chain. Muskellunge spawn later than walleye or northern pike when water temperatures are between 49 and 60˚F (peak 55˚F). These water temperatures are typically reached in mid-May. They prefer shallow bays with hard sand bottoms and limited vegetation. Other gamefish associated with this habitat type include panfish and bass.

Fisheries of the Manitowish River

Forty-two fish species have been recorded between the dam and the Turtle Flambeau Flowage. A list can be found on Table 6. Overall, fish species richness in the Manitowish River is thought to be very good. However, the populations of resident gamefish such as smallmouth bass, walleye, muskellunge, and northern pike are believed to be relatively low in density based on catch rate statistics from past survey results. Lake Sturgeon will be discussed in detail in the Tribal resources section below.

Fish Associated with Rocky River Bottom Habitat

There are a number of fish species that would not persist in the river system, or would be less common, if there were no areas of rocky riffle habitat in the river system as indicated in the table 6. This habitat is limited on the Manitowish River below the dam and is very important to the species that are dependent on sufficient water levels and flows in this habitat type. The section of river below the Highway 51 bridge provides the highest quality riffle habitat for these species.

Fish Associated with Aquatic Bed Wetlands in the Oxbows & Backwaters

Various species and age classes of fish use backwater wetland sloughs that are connected to the river channel for spring spawning, feeding, and resting throughout the open water season. Northern pike, muskellunge, and grass pickerel in particular require flooded vegetated-type habitat for spawning in the early spring just after ice out. Survival of newly hatched fry and fingerlings of these species are also dependent upon continuous surface water in the wetland sloughs in spring and early summer for food and hiding cover in order to survive. Most of the non-game minnow species and panfish species are dependent upon this type of habitat as well. These species provide an important forage base for a number of different fish and wildlife species.

Table 5. Fish on the Chain of Lakes. Presence is based on survey work completed in 2002-05. (Cisco is based on electrofishing surveys conducted since 1972)

Species	Abundance	Wild Rice	Alder	Manitowish	Little Star	Spider	Stone	Island	Rest	Clear	Species Notes:
Muskellunge	Common	X	X	X	X	X	X	X	X	X	Currently Stocked, known NR
Northern Pike	Common	X	X	X	X	X	X	X	X	X	
Grass Pickerel	Present	X	X	X	X		X	X		X	
Walleye	Abundant	X	X	X	X	X	X	X	X	X	Stocked in past, Good NR
Yellow Perch	Abundant	X	X	X	X	X	X	X	X	X	
Johnny Darter	Present							X	X	X	
Iowa Darter	Present							X			
Log Perch	Present	X						X	X		
Largemouth Bass	Common	X	X	X	X	X	X	X	X	X	
Smallmouth Bass	Common	X	X	X	X	X	X	X	X	X	
Bluegill	Common	X	X	X	X	X	X	X	X	X	
Pumpkinseed	Common	X	X	X		X	X	X		X	
Longear Sunfish	Rare						X				State Threatened
Rockbass	Common	X	X	X	X	X	X	X	X	X	
Black Crappie	Common	X	X	X	X	X	X	X	X	X	
Burbot	Present	X	X	X	X	X	X	X	X	X	
Lake Herring (Cisco)	Present			X	X	X		X	X	X	State Special Concern
White Sucker	Abundant	X	X	X	X	X	X	X	X	X	
Golden Redhorse	?		?	?		?					ID issues
Greater Redhorse	Present	X				X	X	X			State Threatened
Silver Redhorse	Present	X	X			X	X	X			
Shorthead Redhorse	Present					X	X	X			
Black Bullhead	Present	X	X	X		X		X	X		
Yellow Bullhead	Present	X	X	X	X	X	X	X	X	X	
Trout Perch	Present	X									
Central Mudminnow	Present								X		
Mottled Sculpin	Present	X							X		
Blackchin Shiner	Present							X		X	
Bluntnose Minnow	Present								X	X	
Common Shiner	Present	X		X						X	
Creek Chub	Present	X	X	X	X	X		X			
Emerald Shiner	?	X									ID issues (Rosyface Shiner?)
Golden Shiner	Common	X	X	X		X	X			X	
Mimic Shiner	Present		X					X	X	X	
Spotail Shiner	Present	X	X					X	X		

Table 6. Fish Species Documented on the River Below the Rest Lake Dam

Species found on the Manitowish River downstream of the dam	Spawn in rock/riffle areas	Use rock riffle areas during non-spawn periods
BLACK BULLHEAD	No	No
BLACK CRAPPIE	No	No
BLACKCHIN SHINER	No	No
BLACKNOSE DACE	Strong	Strong
BLACKNOSE SHINER	No	No
BLACKSIDE DARTER	Moderate	Moderate
BLUNTNOSE MINNOW	Moderate	No
BRASSY MINNOW	No	No
BROOK STICKELBACK	No	No
BURBOT	Moderate	Moderate
CENTRAL MUDMINNOW	No	No
COMMON SHINER	Moderate	Moderate
CREEK CHUB	Moderate	Weak
FANTAIL DARTER	Strong	Strong
GOLDEN REDHORSE	Strong	Moderate
GOLDEN SHINER	No	No
GRASS PICKERAL	No	No
GREATER REDHORSE	Strong	Moderate
HORNYHEAD CHUB	Strong	Strong
IOWA DARTER	No	No
JOHNNY DARTER	Weak	No
LAKE STURGEON	Strong	No
LARGEMOUTH BASS	No	No
LOGPERCH	Moderate	Moderate
MIMIC SHINER	Weak	No
MOTTLED SCULPIN	Moderate	Moderate
MUSKELLUNGE	No	No
NORTHERN HOG SUCKER	Strong	Strong
NORTHERN PIKE	No	No
NORTHERN PIKE X MUSKELLUNGE	No	No
PUGNOSE SHINER	No	No
PUMPKINSEED	No	No
ROCK BASS	Moderate	Moderate
ROSYFACE SHINER	Strong	Moderate
SHORTHEAD REDHORSE	Strong	Weak
SILVER REDHORSE	Strong	Moderate
SMALLMOUTH BASS	Moderate	Moderate
SPOTFIN SHINER	No	No
WALLEYE	Strong	No
WHITE SUCKER	Strong	Weak
YELLOW BULLHEAD	No	No
YELLOW PERCH	No	No

"strong"
means the use is obligate - if rocky riffles aren't present or accessible/usable at the appropriate time of year (i.e. dewatered), the species won't persist in the system

"moderate"
means rocky riffles are preferred but not critical - without riffles the species could still be viable in the system, although it would likely be less common

"weak"
means the species will use riffles on occasion, but they aren't preferred or necessary

"no"
means the species typically doesn't use riffles

Wildlife Upstream and Downstream of the Dam

Wildlife most affected by the management of water levels and flows upstream and downstream of the dam includes species associated with wetlands connected to the affected lakes and river corridor or the shallow open water habitat of lake bays and river oxbows/backwater areas. One important source of food and cover for wildlife, wild rice, is discussed in the Tribal resources section of this document.

Waterfowl

The species of waterfowl that are known to this system include Mallards, Wood Ducks, Common and Hooded Mergansers, Common Goldeneyes, Black Ducks, Trumpeter Swans, Canada Geese, Pied-billed Grebes, and Blue-winged Teal. These waterfowl species arrive shortly after ice-out from mid-March to early May, and shortly after arrival, they begin to search for and establish their nesting areas. Perhaps the earliest nesters are geese who begin to nest as soon as snow and ice cover have receded. If initial nests fail, they may produce a second nest. Mallards, geese, Black Ducks, and Blue-winged Teal nest in uplands and wet meadows adjacent to the rivers and lakes. Wood Ducks, Common and Hooded Mergansers, and Goldeneyes, prefer to nest in tree cavities and search out wooded areas next to a river or lake for nest sites. All species of waterfowl feed on invertebrates and/or vegetation found in emergent and submergent wetland areas. The abundance of invertebrates for waterfowl in these areas is especially important to hens in the spring when their diet is comprised almost entirely of insects to get the protein needed for egg production (Ringleman, 1990). Ducklings of all species feed heavily on aquatic invertebrates for the first two or three weeks after hatching. Broods are hatched between mid-May through June and are not able to fly until around July. The young of all the above mentioned species find cover and food in undercut banks, emergent wetlands, shallow bays, and backwater areas along lakes and the rivers. While ducklings are flightless, they require emergent vegetation to hide in and escape from predators and to provide shelter from the weather. Shallow flooded wetlands adjacent to lakes on the Chain and riparian wetland sloughs/oxbows that support wild-celery, sago pondweed, and other aquatic plants later in the growing season provide an important food source for waterfowl, particularly trumpeter swans and diving ducks. The waters and wetlands of the Manitowish River also serve as a travel corridor during the adult flightless period in the molting phase. This period occurs during the post-breeding period, and the timing varies among species and is regulated by the number of daylight hours, hormonal changes, and local nesting conditions. The flightless period is in May through July for Black Ducks, Mallards, and Mergansers and is June through August for Teal and Wood Ducks. During the molt, waterfowl use large expanses of open water as well as emergent vegetation to find adequate food resources and cover from predators. During this flightless period, waterfowl are dependent on the resources of a single wetland for about a month.

Loons

Studies of the Common Loon territories in 2007 revealed that there were 10-12 loon territories on the Chain. Nest initiation usually begins around May 3, peaks May 21, and ends July 4. Loons are on nests for about 29 days. The majority of the nesting occurs May 15-June 30. In general, loons nest within 1 foot of existing water level, often level with the shoreline, or at most, on nests built up 8-12 inches.

Wetland Birds

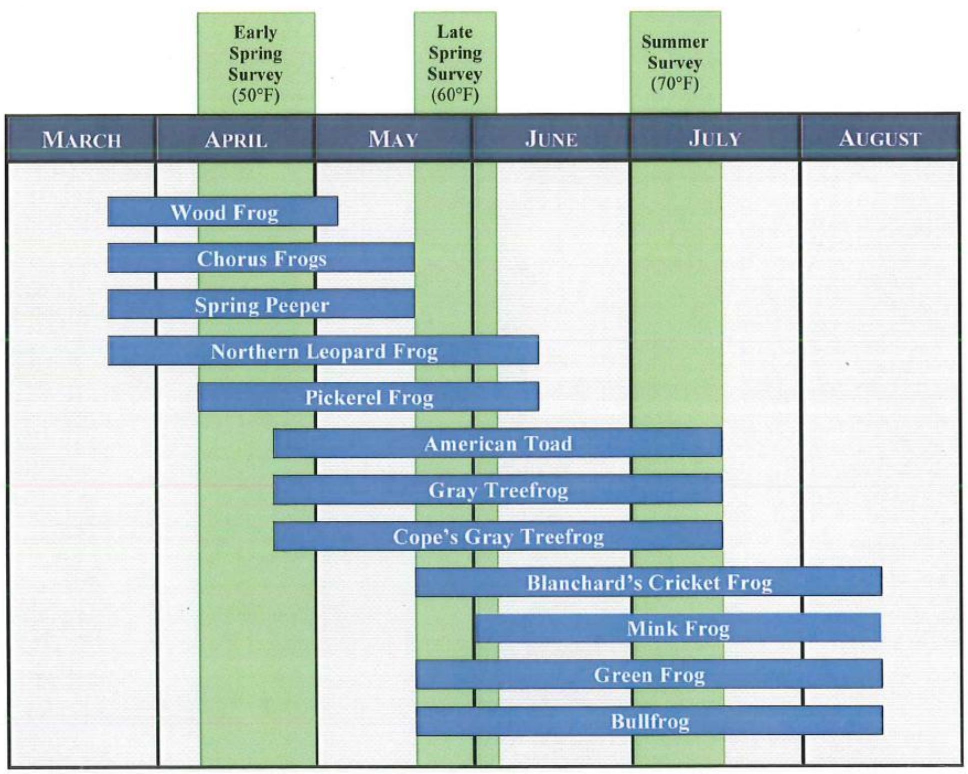
The extensive acreage of wetlands below the dam and on the Chain provide important feeding, cover, and nesting areas for a number of bird species. Birds that are strongly associated with open wet meadow habitat include the American Bittern, Least Bittern, Great Blue Heron, Spotted Sandpiper, Wilson's Snipe, Sedge Wren, Nelson's Sharp-tailed Sparrow, Northern Harrier, Pied-billed Grebe, Sora, Red-winged Blackbirds, and Swamp Sparrows. Common Yellowthroat, Yellow Warbler, Alder Flycatcher, Swamp Sparrow, Song Sparrow, Gray Catbird, Red-winged Blackbird, Eastern Kingbird, Golden-winged Warbler, American Goldfinch, Cedar Waxwing, Black-billed

Cuckoo, American Redstart, Mourning Wabler, and White-throated Sparrow are found in the shrub dominated wetland areas. Sandhill Cranes usually feed in wet meadows and nest in shrub/scrub wetlands where their nests are well hidden. The American and Least Bittern are perhaps the most closely associated with the wetland-open water edge along the river and lakes on the Chain. These species feed on amphibians and other animals in the sedge meadows and emergent marshes close to the water's edge. Studies of the preferred breeding habitat for the American Bittern describe that their preferred breeding habitat is thick marsh grass within 18 feet of water (Robbins 1991). Research has shown that American Bittern populations are higher in sedge meadows with wetter conditions (Mossman and Sample 1990, Robbins 1991, Dechant et al. 2003a). The peak of egg laying for this species is between May and early June and the peak of hatching is in mid June. When mud flats are exposed on the lakes and river, a number of bird species such as the Lesser Yellowlegs, Spotted Sandpiper, and the Solitary Sandpiper forage for insects in these areas.

The emergent wetlands along the Manitowish River also provides habitat for bird species that nest on floating vegetation or muskrat dens very close to the water surface. Black Terns (State Endangered) will described in the section on state threatened and endangered species below. Other species with similar nesting habitat includes the Pied-billed Grebe and Sora Rail.

Reptiles and Amphibians
There are several species of salamanders, frogs, toads, and snakes that are commonly found in northern Wisconsin. Most species of salamander that live in woodlands typically use aquatic habitats only for breeding (usually small woodland ponds). Exceptions are the central newt and mudpuppy. Mudpuppies are entirely aquatic and live on the bottom of large lakes and rivers. The frog and toad species that likely use the wetland and shallow water areas of the Chain of Lakes and the Manitowish River during the growing season include the wood frog, chorus frog, spring peeper, and Eastern American toad. The wood frog, chorus frog, and spring peeper breed in seasonally flooded wetlands. The Eastern gray tree frog requires wetlands that hold water longer, through late summer, so they can remain underwater as they undergo metamorphosis. The bull frog, green frog, and mink frog remain in permanent water all year and are found hiding among the emergent vegetation and riparian plants along shorelines that have little or no housing development. The Northern leopard frog breeds in a variety of wetlands. The Eastern American toad breeds most commonly in seasonally flooded

Figure 21. Breeding Period for Wisconsin Frogs



(Source: Wisconsin Frog and Toad Survey) wetlands, shallow bays of lakes, and river oxbow/backwater areas. Most frog species prefer to breed in seasonally flooded wetlands and ponds that are isolated from lakes and rivers to reduce fish predation on their eggs and tadpoles. The approximate breeding times for these species is shown on the figure 21. At the end of the growing season, around September and October, the chorus, northern leopard, bull, green, and mink frog will begin to look for suitable underwater over-wintering areas.

There is high quality habitat along the shoreline of the Chain of Lakes and along the river corridor for the four species of turtles that are commonly found in this part of the state: common snapping turtle, Eastern spiny softshell, painted turtle, and wood turtle. One species, the Wood turtle is a State-threatened species and will be discussed separately in the Threatened and Endangered Resources section of this document. Although there is extensive habitat available, turtle populations appear to be low upstream and downstream of the dam. In general, turtles need aquatic habitat that has woody debris for basking and resting, access to uplands for egg laying, and shallow wetland areas with submergent and emergent vegetation where they feed on invertebrates and minnows and also hide from predators. Shallow wetland areas also warm more quickly compared to deeper water areas and the warmer water temperatures are especially sought out during early spring and late fall. All of the turtle species that would be present above and below the dam spend their winters under the ice either buried in, or on the surface of, lake and river bottom substrate. Similar to the species of frogs that overwinter underwater, turtles generally begin to seek out underwater overwintering areas around October 1st.

Many of Wisconsin's snakes such as northern water snakes, garter snakes, and fox snakes will use aquatic habitat in the spring and summer. These species spend the late fall and winter dormant in underground burrows. Those that chose overwintering sites in the floodplain of the Manitowish River below the dam may become flooded during the drawdown of the Chain.

Mammals
With the large wetland acreage connected to the Chain of Lakes and the Manitowish River, there is abundant habitat for muskrats, but currently the populations are very low, especially on the Chain. These animals are active all year and feed primarily on wetland vegetation. Their chief food includes cattail, arrowhead, spike rush, water bulrush, pickerel weed, and large-leaved pondweed which are found in the lake bays and riparian wetland sloughs of the Manitowish River system. Muskrat dens are built in shallow water or on lake/river banks with the entrance and exit to the den site being underwater. If water levels drop, exposing a den entrance, there is increased predation and den abandonment. This species also feeds all winter on vegetation under the ice and adequate water depths are needed to allow movement between food sources and their den entrances. When present, their feeding and den building behavior creates areas of open water, and this patchwork of aquatic vegetative density provides habitat diversity for other plant and animal species. This habitat diversity created by muskrats can be seen on figure 22 which is a photo taken on a backwater of the Wisconsin River near Rhinelander, Wisconsin.

Figure 22. Muskrat Dens and patch work of open water/ aquatic vegetation in Wisconsin River wetlands.

Mink use shallow wetland areas and are dependent on muskrat, crayfish, minnows, and mussels as the important components of their food base. They also require adequate water levels to move about under the ice while seeking prey.

Beaver are continually attracted to the habitat provided by the rivers and lakes, but are only occasionally observed in the wetlands that are affected by the operation of the dam.

Mussels

Mussels are an important component of aquatic ecosystems, and they are also an important source of food for otters, muskrat, herons, and other aquatic birds. Mussels are generally found in small to large groups, or 'beds', and although they are somewhat mobile, mussels cannot quickly respond to fluctuating water levels or other environmental hazards. Sixteen species of mussels have been documented on the Manitowish system above and below the dam as shown on the table 7. The species of mussels that would be least affected by the operation of the dam are those that are almost always found in deeper water such as the Round Pigtoe. Habitat availability of species associated with shallow waters is affected by the operation of the dam.

Table 7. Mussel Species Documented on the Manitowish River

Scientific name
Actinonaias ligamentina carinata (Common name: Mucket)
Alasmidonta marginata (Common name: Elktoe)
Amblema plicata plicata
Andonta cataracta marginata
Anodonta grandis form *grandis*
Anodonta imbecillis
Anodontoides ferussacianus
Elliptio dilatata
Fusconaia flava
Lampsilis siliquoidea
Lampsilis cardium
Lasmigona compressa (Common name: Creek Heelsplitter)
Lasmigona costata
Ligumia recta (Common name: Black Sandshell)
Pleurobema sintoxia (Common name: Round Pigtoe)
Strophitus undulatus undulatus

Dragonflies

The Green faced Clubtail (*Gomphus viridifrons*), Skillet Clubtail (*Gomphus ventricosus*), and Zebra Clubtail (*Stylurus scudderi*) are all dragonfly species that have been recorded within the Manitowish River system and likely occur both above and below the dam (Northern Highland-American Legion State Forest Biotic Inventory, 1999). Originally listed by WDNR as a species of Special Concern Status, they have all been moved to the 'watch list', indicating that their statewide populations are no longer believed to be in decline. There have not been any formal dragonfly surveys of the Manitowish River or lakes so it is likely that many more species are present. All species of dragonflies require aquatic systems for breeding, but habitat requirements and breeding seasons vary according to species. Eggs are deposited into the water by free-flying adults and upon hatching, the larvae are exclusively aquatic, only leaving the water to undergo metamorphosis into adults. With respect to water levels, the most critical time in a dragonfly's life history is during the egg stage, when it is immobile. The habitat requirements of the different life stages vary from shallow, calm water areas to deep free flowing areas of a stream depending on the specific species. The Green-faced Clubtail has the earliest flight period of the three species and is in flight from late May to early June. This species generally uses the shallow water adjacent to the stream banks for depositing eggs. Skillet Clubtails are also somewhat early in their breeding biology, but are about a week later than the Green-faced Clubtails. The habitat they seek for egg laying is more generalized, using both mid-stream habitat and water near the stream banks. The Zebra Clubtail has a flight period much later than the other two, extending from late June through the month of August. This species requires sand bottoms for egg deposition, and any depth of water within the stream is suitable for the eggs and larvae of this species.

Crayfish
Rusty crayfish (*Orconectes rusticus)* is a non-native invasive species in Wisconsin (Hobbs, et. al., 1988). They have been present in the reservoir and the river downstream of the dam since the mid 1970's. Given the life history traits of this species, populations are not expected to be affected by the operation of the dam. Other species of crayfish have been documented but a comprehensive WDNR survey has not been conducted.

<u>State Threatened and Endangered Resources</u>
Greater Redhorse (Moxostoma erythrurum) – State Threatened
The Greater Redhorse (pictured below) is found throughout the Chain and also in the Manitowish River below the dam (WDNR unpublished data). The greater redhorse has recently been recommended for delisting as a threatened species in Wisconsin since the populations appear stable and are found in multiple watersheds (Lyons, et. al., 2000). This species is a late maturing, long-lived fish that does not reach sexual maturity until after 5 or 6 years.

Figure 23. Greater Redhorse

Similar to other species of redhorse, the Greater Redhorse spawns in rivers at rocky areas with higher water velocities during the spring or early summer. Lake inhabiting Greater Redhorse will either migrate up river tributaries or spawn in shallow areas of lakes (Kwak and Skelly 1992). Habitat models developed by the United States Forest Service (USFS) indicate that spawning occurs at water temperatures between 62 and 66˚F, and spawning is stimulated when highly variable spring flows begin to subside and stabilize (Healy 2002). This generally occurs in June. The primary spawning area for this species below the dam is located on the gravel, cobble, and boulder section of the Manitowish River between Sturgeon Lake and Highway 51. The cross sections of this stretch of the river have been surveyed and the depth of water measured for a range of river flows. A flow of 75 to 150 cfs is needed to provide enough water to make the majority of the suitable, rocky spawning habitat accessible for this. The larval fish stage of this species occupies shallow vegetated areas near shore with slow water velocities (Scheidegger and Bain, 1995).

Figure 24. Pugnose Shiner

Pugnose Shiner (Notropis anogenus)- State Threatened
The Pugnose Shiner is a state threatened species that is found on the Manitowish Chain, Trout River, and on the river below the Rest Lake dam (Lyons et. al., 2000). The species is characterized as a "secretive" fish that is closely associated with dense submergent vegetation in lake bays and low gradient river runs and backwaters (COSEWIC 2002). They feed on and among aquatic

plants, feeding on filamentous green algae and microorganisms. Spawning also takes place in these densely vegetated areas, occurring between May and July.

Longear Sunfish – State Threatened
The Manitowish system is at the far northern range for this species. In Wisconsin there are only a few documented populations. The prefer streams that are clear, shallow, low current, moderately warm areas with aquatic vegetation. This species appears to be established and reproducing in the Manitowish Chain. The species was found in Stone Lake during surveys in 1981 and 2004. There is also a well-established population of this species in the Trout River that connects Trout Lake to Wild Rice Lake. They do not appear to be abundant in the Chain at this time.

Wood Turtle – State Threatened
Wood turtles are semi aquatic species that prefer lowland hardwood forests and open wet meadows associated with moderate to fast current streams and rivers with sand or gravel substrates. With the good water quality and the extensive area of undeveloped riparian meadow, wooded, and shrub/scrub areas, the Manitowish River provides habitat for this threatened species. Wood turtles are a long-lived species that do not reach sexual maturity until 10-14 years. They are semi-aquatic and often forage in upland forests and meadows in the summer but are aquatic generally from March to April and October to November when most of the breeding occurs (Bowen, K.D. & Gillingham, J.C. 2004). Nesting usually occurs around mid-June, and eggs are laid on south facing river banks, sandy areas, and road shoulders. Juvenile wood turtles are associated with different types of habitat throughout the year, but studies of juvenile wood turtle habitat preferences in northern Wisconsin have shown that areas between alder thickets and open grassy areas near river channels consistently have the highest frequency of occurrence (Brewster and Brewster, 1991). Over the winter, this species is found in riverbanks or on the bottoms of streams and rivers.

Black Terns – State Endangered
Black terns were previously listed as a species of special concern but where changed to State Endangered in 2012. This species has been documented nesting on the Manitowish River where it enters the Turtle Flambeau Flowage. Black terns prefer large shallow marshes with abundant vegetation adjacent to open water. Nests are built in Mid May through July on floating structures or near open water. Nests are susceptible to flooding when there are changes in water levels during the breeding season. Water levels that encourage the stability of emergent vegetation would improve habitat for Black Terns.

6. Cultural Environment

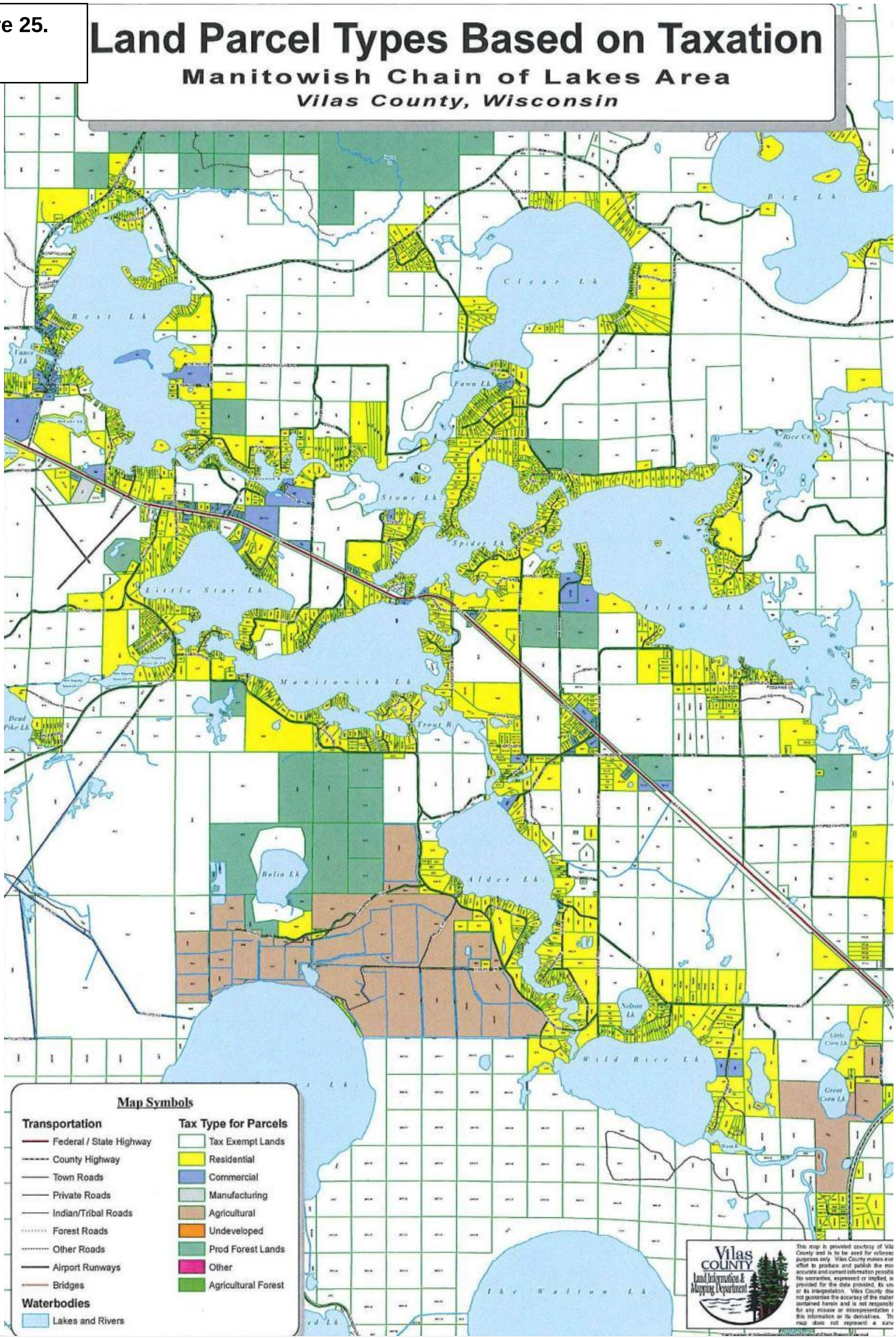
a. Land use (dominant features and uses including zoning if applicable)

Most of the residential and commercial land use in the Manitowish Waters area both above and below the dam is based on tourism. People visit the area for a number of reasons including fishing, hunting, and pursuing other recreational activities.

The majority of the Chain lies within the Township of Manitowish Waters, with the exception of parts of Clear, Island, and Wild Rice Lakes that reside in the Township of Boulder Junction, and the southern portion of Wild Rice Lake that is within the Lac du Flambeau Indian Reservation. On the Manitowish Chain of Lakes, there is dense residential lakeshore development and, according to information provided by the Manitowish Waters Lake Association, there are 1,378 private lake lots on the Chain (depicted in yellow on figure 25). According to information posted on the Manitowish Waters Chamber of Commerce website, there is one marina, one motel, one bed and breakfast, and twenty-four cabins and resorts located on the Chain. When accommodations and seasonal homes are occupied, along with an estimated 400 seasonal day visitors, the total population has been estimated to rise from 682 to 4,882 persons in the township (Town of Manitowish Waters Year 2022 Comprehensive Plan). In addition to residential development on the Chain, most lakes also have some portions of the shoreline that are public lands, mostly managed by the DNR as part of the Northern Highland American Legion State Forest. There is limited agricultural land use associated with cranberry production near Wild Rice and Alder Lakes.

The Manitowish River is also in the Township of Manitowish Waters from the dam to about a half mile past Benson Lake. From that point to the confluence of the Bear River, the Manitowish travels through the Townships of Mercer and Sherman. The majority of year-round and seasonal residential development on the river below the dam has occurred around Vance, Benson, and Sturgeon lakes, along the Highway 51 corridor, and smaller lots near the intersection of Highways 51 and 47. There are also a small number of resorts, restaurants, and businesses located downstream of the dam. Downstream of Highway 47, the river is surrounded almost entirely by public lands owned by the DNR.

Figure 25.


Land Parcel Types Based on Taxation
Manitowish Chain of Lakes Area
Vilas County, Wisconsin
Big Lk.
Clear Lk.
Rest Lk.
Vance Lk.
Fawn Lk.
Rice Cr.
Stone Lk.
Spider Lk.
Little Star Lk.
Island Lk.
Manitowish Lk.
Dead Pike Lk.
Trout R.
Bolin Lk.
Alder Lk.
Nelson Lk.
Wild Rice Lk.
Little Corn Lk.
Great Corn Lk.
The Walton Lk.
Map Symbols
Transportation
Federal / State Highway
County Highway
Town Roads
Private Roads
Indian/Tribal Roads
Forest Roads
Other Roads
Airport Runways
Bridges
Waterbodies
Lakes and Rivers
Tax Type for Parcels
Tax Exempt Lands
Residential
Commercial
Manufacturing
Agricultural
Undeveloped
Prod Forest Lands
Other
Agricultural Forest
Vilas County
Land Information & Mapping Department

b. Social/Economic (including ethnic and cultural groups)

<u>Natural Resources in the Ceded Territory</u>

The Manitowish River system is located in the Ceded Territory of Wisconsin, and Tribal hunting, fishing, and gathering rights are accorded as a matter of federal treaty. Prior to the arrival of Europeans in North America, Indian tribes were independent, sovereign nations. Although the Chippewa tribes ceded their land in the northern one-third of Wisconsin to the United States government in the Treaties of 1837 and 1842, they reserved their off-reservation rights to hunt, fish, and gather within the Ceded Territory. As a result, the Lake Superior Chippewa tribes of Wisconsin are allowed to harvest rice and legally harvest walleyes and muskellunge using traditional methods, including spearing and gillnetting, on lakes within the Ceded Territory. The Lac du Flambeau Band of Lake Superior Chippewa Indians is the tribe that primarily practices their traditional hunting and fishing rights on the Manitowish River system. The Lac du Flambeau Chippewa Reservation has been a permanent settlement of the Lake Superior Chippewa Indians since 1745 when Chief Keeshkemun (Sharpened Stone) led his band to the Manitowish River area for wild rice, fish, and game. The Lac du Flambeau Indian Reservation is located 12 miles northwest of Woodruff and Minocqua in southwestern Vilas County and the southeastern portion of adjacent Iron County.

Wild Rice

An important cultural resource on the Manitowish River system is wild rice (*Zizania palustris*), and large beds are present above and below the dam. In addition to being an important traditional food source harvested by Native Americans, wild rice beds also provide an important food source for waterfowl during fall migrations, good cover for brood rearing habitat for ducks, nursery areas for young fish and amphibians, and a food source for a number of bird species and herbivores such as muskrats.

Figure 26. Harvesting Wild Rice

Rice is an annual plant that grows in about 0.5 to 3 feet of water, and it does best in the presence of flowing water including rivers and lakes with inlets and outlets. Winter drawdowns may benefit wild rice because it helps the annual wild rice plant to effectively compete against water shield and other perennial macrophyte species. Water level fluctuations in May and June are detrimental to wild rice because it is at a critical growth stage called the floating leaf stage. During this time, the wild rice plant is reaching the surface of the water and has started to grow a leaf that looks like a ribbon which floats on the water surface at a 90 degree angle to the stalk. If water levels rise, then the floating leaf can pull the wild rice root out of the lake bottom. The plants can also drown at this stage because the plant has begun a physiological change and has begun exchanging gases it needs from the air (Rogosin 1954, Kahl 1993, Fannucchi et al. 1986). If water levels decrease, then the stalk can collapse.

The wild rice acreage upstream of the Rest Lake Dam is mapped based on aerial surveys conducted by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). Over the past ten years, the average acreage at peak years is as follows:

- Island Lake (at Rice Creek) ~80 acres
- Island Lake (at Manitowish River) ~60 acres
- Rest Lake (at Papoose Creek) ~12 acres
- Wild Rice Lake and Trout River ~15 acres

Figure 27. Photo taken by GLIFWC of the wild rice beds where the Manitowish River enters Island Lake

There are also a number of wild rice beds located on the Manitowish River below the dam, but the total acreage is not known because the wild rice primarily grows along the river's edge and the area of the beds are difficult to identify in aerial photos. The wild rice on the river is an important food source for waterfowl but is not commonly harvested because the rice on the river is a shorter growing variety that is difficult to harvest in canoes.

Walleye and Musky Harvest

The six Chippewa tribes of Wisconsin are legally able to take walleye and muskellunge in the Ceded Territory using traditional harvest methods. Walleye, and to a lesser extent muskellunge, are harvested annually on most of the lakes on the Rest Lake Chain. The harvest during the walleye spawning period begins shortly after ice off, when the Chain is at the winter 5' 0" water level, and generally continues two to three weeks.

Lake Sturgeon (Acipenser fulvescens)
The lake sturgeon is an important species to Native American culture as a traditional source of food, and also serves an important role in tribal ceremonies and creation stories. The restoration of Lake Sturgeon in the Manitowish River is a recommendation of the Wisconsin statewide sturgeon management plan which can be viewed at the following weblink: http://dnr.wi.gov/fish/sturgeon/mngtplan/ .

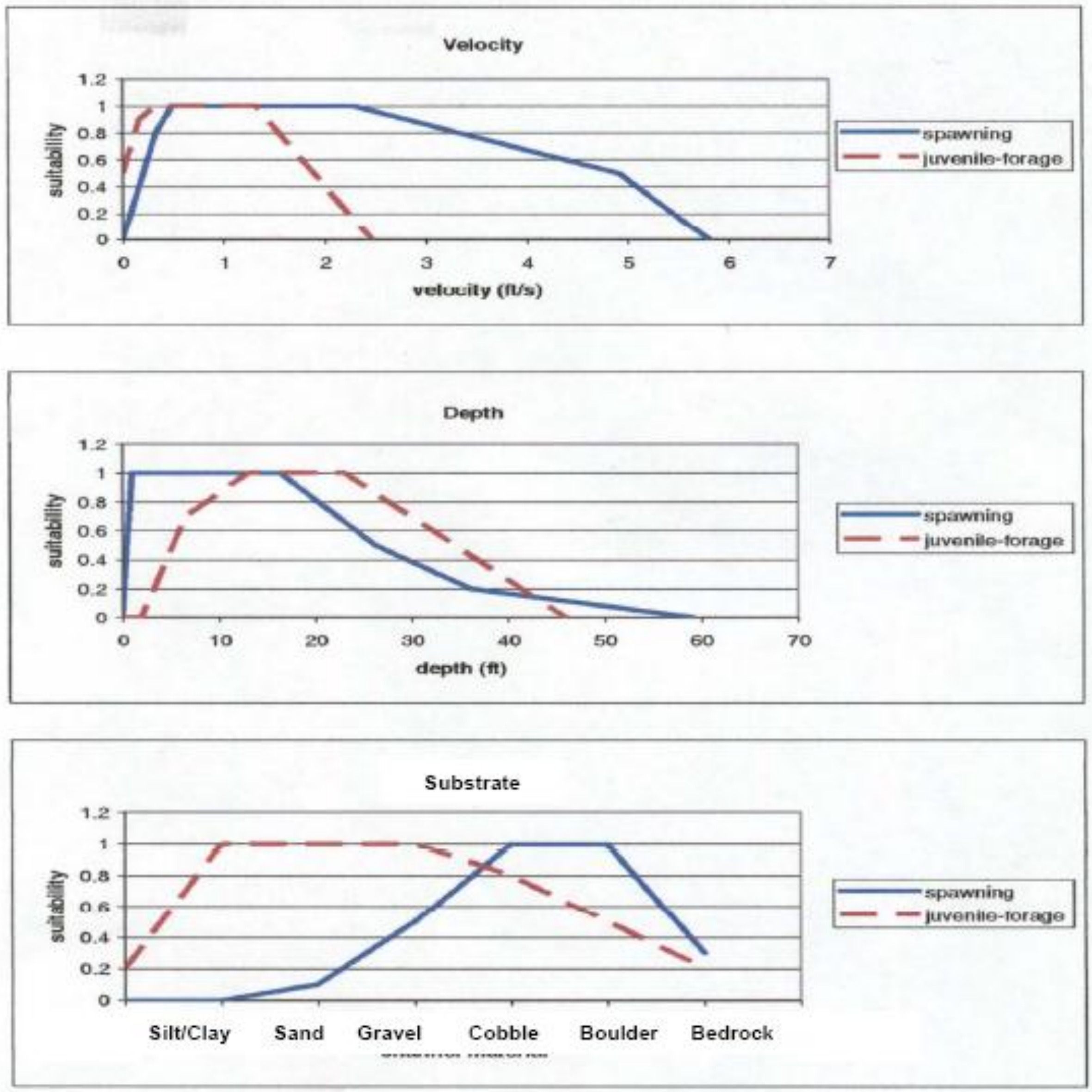
There are no official accounts of lake sturgeon occurring in any lakes or streams in the upper Manitowish system before or after the Rest Lake dam construction. However, it is likely that lake sturgeon were historically present above the dam and a few individuals may still be present (although no documentation of this currently exists). Since 1990, the Wisconsin DNR has been periodically sampling for, and studying, lake sturgeon in the Turtle Flambeau Flowage (TFF) and the Manitowish River system. Beginning in 1991, a radio telemetry study was initiated in order to monitor seasonal movements of lake sturgeon within the system. Sturgeon implanted with radio transmitters in Benson Lake and the TFF generally migrated between the flowage and the rocky area below the Highway 51 bridges. Many of the fish tagged in the TFF migrated to Benson Lake in the fall prior to spawning, and after spawning, returned to the TFF.

Lake sturgeon have been observed spawning in the limited rocky areas below the highway 51 bridge. Although it is not certain, these observations, along with field observations of radio-tagged fish, provide strong evidence that most spawning activity occurs in the rocky areas below the Highway 51 Bridge. It is also possible that some spawning could occur at the confluence of the Bear and Manitowish rivers where walleye are also known to spawn, or on other inflow tributaries to the TFF system Neither of these areas are thought to provide the extent or quality of habitat compared to what exists below the Highway 51 bridge.

Figure 28. Picture of a Lake Sturgeon

Detailed habitat models have been developed to quantify the water velocity, depth, and substrate needed for suitable spawning habitat (figure 29). Sturgeon require clear rock, cobble and boulder spawning habitat that is not covered with silt and that has adequate river flow to create sufficient water depth and clean interstitial spaces between rocks to keep incubating eggs well oxygenated. Spawning begins when higher spring flows and rising water temperatures cue sturgeon to begin their movement into the spawning grounds. Optimum conditions include temperatures of 53 to 61 degrees Fahrenheit, water velocities between 1.64 to 4.92 feet per second, and a water depth of 18 inches or more. On the Manitowish River, these conditions are associated with river flows between 125 and 200 cfs or more. Based on three years of temperature data on the Manitowish River, suitable spawning water temperatures generally occur between May 1st and June 6th. After successful spawning, it takes approximately 5 to 8 days for eggs to hatch and young fish to begin to drift downstream. For the first year of life, young fish will use the main river channel in vegetated areas adjacent to sand and gravel bars. Adult sturgeon required adequate areas of water less than 30 feet deep where abundant food is produced. Below the Rest Lake Dam, Vance Lake, Sturgeon Lake, Benson Lake, and the TFF offer suitable habitat for adults. Lake sturgeon have been found to primarily feed on small crustaceans, mollusks, and lakefly larvae (Schmitt et. al. 2009).

Figure 29. Lake Sturgeon Habitat Suitability Curves.



Economics

Tourism

The high density of lakes, rivers, wetlands, and public recreational areas attract many people who visit the area to boat, fish, camp, hike, paddle, bird watch, or engage in other activities that the region offers. The money spent by tourists is an important base of the local economy, and the amount spent in Manitowish Waters was estimated in the Town's Year 2022 Comprehensive Plan. According to a study for the Wisconsin Department of Tourism, visitors to Vilas County spent $185.7 million dollars in 2000. To figure out the percent of this that was spent in Manitowish Waters, State of Wisconsin Division of Health records were used to determine the percentage of lodging accommodations available in the town versus the county. That percentage was applied to the total tourism spending in the County. Using this method, Manitowish Waters may benefit from an estimated $12.2 million of expenditures from visitors each year.

Seasonal Residents

Another important part of the local economy comes from the money spent by seasonal residents for food and drink, recreation, construction, and other services. The amount of money spent by this group each year in Manitowish Waters was also roughly estimated in the Town's Comprehensive Plan. Based on a 1995 study of Recreational Homeowners in Wisconsin, there was an estimated $127 million spent by seasonal residents for goods and services in Vilas County. Manitowish Waters has an estimated 6.1% of the total seasonal housing units that are documented in the County. Using this percentage, seasonal residents spend roughly $7.75 million each year in Manitowish Waters.

Property Taxes

The property taxes on the waterfront homes are an important source of revenue for the Township and County government. According to information submitted by the Manitowish Waters Lake Association, the total assessed value of the waterfront homes on the Chain is $418,695,300.

Property

Ordinary High Water Mark

Since 1915, the summer maximum water level at the dam has been set at 8'6", and this water level elevation has strongly influenced the location of the ordinary high water mark (OHWM). The OHWM is defined as the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily recognized characteristic. There are physical and biological field indicators of the OHWM, and this boundary is the separation between privately owned riparian lands and the areas where the public has the right to use the navigable portions of the waterway for activities such as fishing and boating. Since the maximum water level on the Chain has been established for over ninety years, the location of the OHWM has likely remained relatively stable and is located somewhat above the maximum summer water level.

Flowage Rights

According to Xcel staff, the CFIC has limited non-flooded ownership of the flowage bottom on the Manitowish Chain. The company has maintained flowage rights over the submerged lands which give the owners of the dam the right to flood. It is likely that the flooded lands are owned by other parties, which can be public or private entities. A detailed picture of the ownership of the flowage bottom would have to be determined through reviewing the property deeds at the courthouse.

Shoreline Structures

There are many structures such as boathouses, sea walls, piers (permanent and seasonal), riprap, and other shoreline structures located on the Manitowish Chain of Lakes. No formal evaluation has been done to compare the total number or value of structures on the Manitowish to other northern Wisconsin lake chains. High numbers of shoreline structures can also be found on the Minocqua, Eagle River, and Three Lake chains.

To evaluate the potential for boathouses, sea walls, piers, riprap, and other shoreline structures to be affected by different winter water levels, the Chain was surveyed at the 6' 0" level in 2004 (table 8). Structures included in the survey were picked at random and the height above the 6' 0" water level was recorded at each site as shown below. Based on this data, it was then determined if these structures would be wet or dry at different water levels.

Table 8. Structure Survey on the Chain of Lakes

Structure (%) dry (%) wet						
Elevation	5.0	6.0	6.5	7.0	8.0	8.5
	Dry Wet	Dry Wet	Dry Wet	Dry Wet	Dry Wet	Dry Wet
Boathouse	84 16	42 58	29 71	24 76	13 87	11 89
Walls	97 3	86 14	80 20	56 44	0 100	0 100
Docks/piers	46 54	7 93	7 93	7 93	0 100	0 100
Rock Rip-rap	100 0	80 20	40 60	20 80	0 100	0 100
Wood/Stone Bldg.	100 0	100 0	100 0	0 100	0 100	0 100
Foot Bridge	0 100	0 100	0 100	0 100	0 100	0 100
Shed	100 0	100 0	100 0	0 100	0 100	0 100
Deck	100 0	100 0	100 0	100 0	100 0	100 0
Total 100%	83 17	55 45	44 56	32 68	7 93	6 94

The total number and value of permanent structures (other than riprap and seawalls) below the OHWM on the Chain was estimated using results from the 2004 survey, permit records, and aerial photographs. Based on these sources of information, there are approximately 78 wet boathouses, 5 dwellings, and 16 permanent boat shelters. Wet boathouses are structures designed for boat storage that have at least part of their foundation below the OHWM. Wet Dwellings are structures that were built or rebuilt for human habitation that have at least part of their foundation below the OHWM. Permanent Boat Shelters are similar to boathouses except that they have no walls. All three of these structure types are regulated by Chapter 30 (Wis. Stats.). Real estate assessment information was requested and received for wet boathouses, dwellings, and permanent boat shelters located below the OHWM. Using parcel data common to both the DNR survey and the assessment records, 88 of the 99 observed structures (89%) were found to be in the assessment records. The 2008 assessed values and fair market values total $2,111,940 and $3,754,746, respectively.

Shoreline stability

Wind and ice action can have an impact on the shorelines and structures on Wisconsin lakes. The energy that waves exert along the shorelines on the Chain is related to boat traffic, wind speed, depth of the lake adjacent to the shoreline, shoreline vegetation, aquatic vegetation, soil type, and fetch (the length that wind can carry a wave across a lake). The shorelines that receive the highest amount of wave action can be determined using the wave energy calculator found on the following DNR website: http://dnr.wi.gov/waterways/shoreline_habitat/erosioncalculator.html

On average, 75% of the winter ice sheet is gone on the Chain of Lakes by April 20th. The primary mechanisms of ice action are ice-jacking and wind pushing the ice sheet against a shoreline.

Ice-jacking is caused by the expansion of the ice sheet during a temperature rise followed by a contraction with an appreciable drop in temperature. During this expansion and contraction, the ice sheet cracks and those cracks fill with water which freezes and expands the ice a bit further. When a subsequent rise in temperature produces an expansion of the whole ice mass, a tremendous force can be exerted against the shore. Ice jacking primarily occurs on larger lakes such as Lakes Winnebago (137,708 acres), Mendota (9,842 acres), and Koshkonong (10,460 acres) but does not exert much, if any, shoreline disturbance on lakes the size of those on the Manitowish Chain (from 74 to 1,043 acres).

The amount of shoreline disturbance caused by wind action pushing the ice sheet depends on the thickness and strength of the ice sheet, shoreline geometry, wind speed, and fetch. Areas may be more susceptible to this form of ice action if there are gradually sloped shorelines, long fetches and prevailing winds. Prevailing winds predominantly come from the northwest and then typically switch to the southwest during the late stages of the melt period. A wind generated ice push occurs more often on large lakes with long open water fetches of a mile or more. Most of the lakes on the Manitowish Chain of Lakes have a fetch of a mile or less.

Navigation

The Manitowish Chain is heavily used by recreational boaters during the summer months. There is a wide range of recreational craft used including large power boats and pontoon boats. There are boat ramp access points on Rest, Clear, Island, and Wild Rice Lakes, and there is carry in access at Clear and Little Star Lakes.

The Manitowish River downstream of the dam is primarily used by small motor boats, canoes, and kayaks. Public access points on the river include the launch at Highway 51, Benson Lake Road, Manitowish River Access Road, the wayside on Highway 51, and the Highway 47 Bridge. Downstream of Highway 47, the river is quite remote. The only access points are at the Turtle Flambeau Flowage at Murray's landing or from Highway 182 by traveling on the Bear River to reach the Manitowish.

c. Archaeological/Historical

There are numerous archaeological sites on the Chain (Stiles, et.al. 1995). Site types include: Native American campsites and villages, Native American burial sites, and Euro-American homesteads and logging camps. Many of these sites are located near the shoreline and many are on islands and peninsulas. Some sites were likely flooded when the Rest Lake dam was originally constructed and some may be partially above and below the 8' 6" water elevation.

7. Other Special Resources (e.g., State Natural Areas, prime agricultural lands)

The Manitowish River system above and below the dam is recognized by many as a unique ecological resource. Above and below the dam, the Manitowish River is classified as an Outstanding Resource Water (ORW) or Exceptional Resource Water (ERW). Waters designated as ORW or ERW are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. Additionally, department biologists that frequently conduct aerial surveys for wild rice or bald eagle surveys have noted that the extensive floodplain wetland complex connected to the Manitowish River is unique to this river system. According to Wisconsin's Wildlife Action Plan, this area is designated as having ecological significance for conservation opportunities areas for wildlife species of greatest conservation need.

The Manitowish River below the dam from Benson Lake to STH 47 is designated as a scenic management area in the Northern Highland-American Legion State Forest Master Plan. As stated in the master plan, "this classification is applied to lands with outstanding scenic attractions, scenic lakes, rivers and stream with high values for water-based recreation". The management objective for this classification "is to protect, maintain, and enhance for long-term public enjoyment lands or water having unique aesthetic qualities or outstanding scenic beauty".

The Manitowish River Wilderness Area (which is downstream from the STH 47 bridge), consists of 6,265 acres with the Manitowish River running through the center. This Wild Resources Management Area is typically applied to "undeveloped areas that have the potential to be restored to a substantially wild condition. These locations are managed to provide land and water areas where natural ecological process predominate and evidence of human activities is low". Within this wilderness area is the Frog Lake and Pines State Natural Area (SNA), which borders the Manitowish River, and the Turtle-Flambeau Pattern Bog SNA located farther downstream.